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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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"Real Meat"

As each year's new volume of the Proceedings of the Institute of British Foundrymen is examined, it becomes obvious that greater attention is being paid to covering the whole of the activities of the industry. Despite this, there are gaps which require to be filled, notably the dearth of Papers dealing with malleable cast iron. A second subject which has been neglected is that of die-casting. Taken as a whole, however, the contents are particularly well chosen, as the following analysis of the Papers shows:—Cast iron (practice and theory), 7; steel, 3; non-ferrous, 4; patternmaking, 2; moulding sands (including cement-sands), 3, and fettling (including a study on chilled iron grit), 2. In addition, there are Papers of general interest. For the first time there is included a Paper from the South African Branch—one on the use of plywood for patternmaking, by Lieut.-Col. W. J. Grose.

An outstanding feature of recent foundry technical literature, which was rare in the past, is the regular appearance of well-illustrated articles describing the actual production of castings. Not so many years ago, such articles were illustrated by rough sketches and a plethora of practical details, exceptions being articles by Mr. James Smith, of South Shields, and Mr. J. Robinson, of Halifax. Nowadays, it is obvious that foundry managers have recourse to both the drawing office and the photographic department for their illustrations. The contributions of Longden, Blakiston, Whitehouse, Roxburgh, Ballantine, Lawrie, Rowe, Jackson and many others, have so enriched British foundry literature of a practical character as to make it the world's best.

The main object of the Proceedings is the provision of a personal reference library, and those foundrymen who possess the complete thirty-one volumes are indeed fortunate, for therein they have the equivalent of a collection of text-books well capable of solving the majority of technical problems liable to arise in everyday practice. We know of no phase of foundry practice or theory which has not been dealt with in their compass. Moreover, because of the excellence of the indexing and general absence of physico-chemical theory dressed up to pass as metallurgy, each new volume yields an extremely high percentage of "real meat."

Muck, Dust and Darkness

Speaking at a dinner given to the representatives of the Technical Press by the directors of Babcock & Wilcox, in Glasgow last Tuesday, Mr. W. P. Johnson, of "Engineering," referred to the foundry as he knew it in his apprenticeship days as an aggregation of "muck, dust and darkness," and stressed the change which had been wrought in the industry since that time. As recently as 1929, on the occasion of the International Foundry Congress, it is true to state that it was then impossible to have shown the visitors more than two or three mechanised foundries. Next June, of the numerous organisations to be visited, no fewer than fifteen possess fully-mechanised sections. Due to such factors as geographical location, time and the rearmament programme, no opportunity presents itself of inspecting another fifty or more foundries entering into this category. At a very modest estimate, a sum of £1,500,000 has been spent during the last decade by the foundry industry in plant and equipment, and whether this investment has been worth while can be safely left to the judgment of our overseas visitors. Whilst the profit motive has obviously been a factor of paramount importance in the decisions taken to mechanise the various foundries, the elimination of "muck, dust and darkness" has also been taken into consideration. The old adage, "where there's muck there's money," is no longer true and it needs revision to read "where there is muck, there is wastage, danger and disease." It is true to say that in certain foundries there is less dust apparent around the continuous casting plant than there is hanging over the hand moulding floor, due to the installation of modern dust-extracting plant. A feature of modern foundry practice is the reclamation of sand, and it was due to the accumulation of this which gave rise to much of the "muck." Finally, the Home Office Regulations insist on adequate lighting. Thus it is shown that the old-fashioned foundry recalled by Mr. Johnson has largely, if not entirely, disappeared.

Welding Research Report

The Third Report of the Welding Research Committee has recently been issued by the Institution of Mechanical Engineers. We append a brief summary.

The Report contains an account of further tests to determine (1) the effect of heat treatment on the fatigue properties of welds; and (2) the differences in the fatigue properties of welds when tested (*a*) as received, (*b*) with the top layer removed so that the weld metal is flush with the surface of the plate; (*c*) machined all over. Repeated stress tests have been carried out on specimens cut from welds prepared simultaneously with the longitudinal joints of boiler drums. Specimens cut from welds of boiler plates 3 in. thick were also tested in two types of repeated stress machines and the results compared with those of the repeated stress tests of the 3-in. welds carried out in a large machine capable of testing thick plates. A critical analysis of the results from the two sets of tests has been attempted. The results of numerous repeated-stress tests are analysed, and curves are given relating the maximum and minimum repeated stresses with the number of repetitions. A curve is also given from which, it is suggested, the reasonably safe tensile fatigue range for any given initial stress can be obtained.

The results of static creep tests and slowly-repeated-stress tests, carried out at 460 deg. C. and 298 deg. C., are given, and show that creep in the welds at these temperatures is not essentially different from that in the plate.

Repeated stress tests have been carried out on three different boiler drums, annealed at 600 deg. C. for 140 min. and then cooled in the furnace. Repeated hydraulic loadings were continued until cracks developed, but in no case did these take place in the welds, showing conclusively that the welds were not the weakest part of the drums.

Combustion Appliance Makers' Association

ANNUAL CONFERENCE

The Combustion Appliance Makers' Association (Solid Fuel) will hold its annual luncheon at the Dorchester Hotel, London, on March 29, and its annual conference at Caxton Hall on the 29th and 30th. The General Council of the Association has appointed Mr. William Rennie, chairman and managing director of Federated Foundries, Limited, as president for the year 1939/40, to succeed Mr. J. Arthur Reavell, who has completed his second term of office. A joint session of the Domestic and Industrial Sections of the Association will be held at 3.30 p.m. on March 29, when Papers by Dr. McCulloch of Manchester University, and Mr. J. G. Bennett, Director of the Association, dealing with the education and professional status of coal utilisation engineers, will be discussed. At 10.30 a.m. on March 30, the Industrial and Domestic Sections will hold separate discussions. The Domestic Session will have under consideration "The Future of Solid Fuel in the Domestic Market," while the Industrial Session will consider a series of Papers under the general title of "The Industrial Significance of the Impurities in Coal." Later there will be a Joint Session of the Domestic and Industrial Sections to discuss a Paper by the Director of the Association, Mr. J. G. Bennett, on "The Evaluation of Performance of Fuel-Using Installations."

SAMUEL FOX & COMPANY, LIMITED, Stocksbridge Works, Sheffield, are putting in a new 10-ton electric furnace.

Publications Received

Transactions of the American Foundrymen's Association. Vol. XLVI. Edited by R. E. Kennedy and N. F. Hindle. Published by the Association from 222 W, Adams Street, Chicago, Ill., U.S.A. Price on application.

This volume, which contains the Papers and reports presented to the 42nd annual meeting held in Cleveland, Ohio, runs to 940 pages, and is commendably well presented. The membership of the Association has now reached the record figure of 2,953, the previous best being 2,477 in 1930. It is interesting to note that the Branches of the Association, or Chapters as they are designated, vary in strength from 35 to 337, and are thus comparable with those organised by the Institute of British Foundrymen. It is this, to the A.F.A., new method of organisation which has increased the membership. There are about 40 Papers and reports included in the Proceedings, and it would be thought that every phase of foundry endeavour would be covered. Yet no Paper is solely devoted to either light alloys or die castings, though H. W. Gillet devoted part of his Paper to silicon in aluminium alloys. Malleable iron castings, if memory does not deceive, do not figure so prominently as in the earlier work of the Association. Studying the work of the A.F.A., it is quickly realised that, as in Great Britain, there are fashions in foundry practice just as much as in ladies' hats, and to derive the maximum benefit from any technical association, prolonged and continuous membership is essential. Sooner or later, the individual interest of each technician gets his fair share, especially if he has the initiative to set the ball rolling at an appropriate time. The high standard of publication which one has learnt to expect from the American Foundrymen's Association has not only been well maintained in the latest volume of Proceedings, but improvements are to be discerned. The reporting is better, whilst the standard of American research work as applied to foundry practice has improved out of all recognition during the last two decades.

Index to A.S.T.M. Standards and Tentative Standards. Issued annually by the American Society for Testing Materials, 260, S. Broad Street, Philadelphia, Pa., U.S.A.

It is extremely courteous of the American Society for Testing Materials to offer to send this extremely useful publication to any of our readers who care to write to America for it. Under the heading of Cast Iron, about two dozen specifications are listed, covering not merely the material *per se*, but also applications, such as cast iron pipes and cylinders.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

The Annual Cricket Match

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The fourth annual cricket match between the Institute of British Foundrymen and the Works Management Association has been arranged to be played on the sports ground of H. P. Bulmer & Company, Limited, Hereford, by the kind permission of Mr. Bulmer. The match will be played on Sunday, June 25. I shall be glad if all friends and supporters will make a note of this date, and all those members of the Institute who have been good enough to play for us will communicate with me at their convenience, with a view to letting me know whether this date is suitable.—Yours, etc.,

J. E. HURST.

Darlaston Blast Furnaces,
Darlaston, Staffs.
March 13, 1939.

Random Shots

In spite of the presence of so much Wood and a Carpenter to boot the annual dinner and dance of the Institute of Metals, which was held in London last week, preserved its usual metallic ring. So far from Wood being the medium of national defence as was the case in Elizabeth's reign, the present-day medium is undoubtedly metal, wooden warships having given place to gleaming aeroplanes. At the dinner Lord Dudley remarked that whenever he saw an aeroplane with its shining face and millions of rivets it reminded him of an overgrown school-boy with the acne! He was one of two speakers to respond to the toast of the guests, and in this connection he told an appropriate story. Staying in a provincial hotel once, he ordered a boiled egg for breakfast. The waiter brought two, and when this was pointed out to him, the reply was that he had brought two in case one might be bad!

* * *

He recounted how once he told a certain story at a dinner, and, sitting down at the end of his speech, asked his neighbour how he liked his story. "Ah, yes. I did like it, in fact I always liked that particular one," came the unconsciously cutting reply.

* * *

Prof. Andrews apologised for his voice, saying that he had only just recovered his stable equilibrium, and still felt a little "horse" after an attack of 'flu. He also told the story of a boy who was asked to state where the elephant was found. The bright youth's reply was that he should have thought that the elephant was far too big to get lost.

* * *

It is encouraging to have had a number of requests for the solution to the Monkey Puzzle. Some readers are just interested to see it; but one has evolved a solution of his own. His letter reminds one of the famous story of the French-Canadian backwoodsman, who wrote a long complaint that no tools had been supplied with the new pump, and then added a tiny postscript: "P.S.—The spanner is at the bottom of the box." This correspondent, after explaining at length how the answer must necessarily be 5 ft., puts a postscript to say that he finds after all that he has made a slip in the last equation, and that he agrees therefore that 7 ft. must be right!

* * *

He suggests that if problems are what foundrymen like, someone might care to solve this one: "What is one three-quarters of?" He adds the suggestion that readers who attend international congresses would find no difficulty in translating this problem into German, but let them try a rapid oral translation into French! He suggests, too, that a mental problem comparable with the Monkey Puzzle is that which requires to know the number of guests and the price per head of a party partaking of afternoon tea consisting of tea, bread and butter, jam and cakes, the total bill being 20s. 0½d.

* * *

Lot 2 from the Barrington Hooper Collection.

Disappointment should always be taken as a stimulant and never as a discouragement.

A gossip is a woman with a strong sense of rumour.

Cook: Did they say anything about the cooking?

New Maid: No, but I noticed them praying before they started eating.

"MARKSMAN."

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Abrasives and Their Application in Foundry Practice*

By H. BROMAGE

After explaining that sandstone was in all probability the first type of grind-stone to be used in the form of a wheel, and also that emery and corundum were the next abrasives to come into use, the Lecturer proceeded to give a detailed description of the manufacture of abrasives commonly used in the grinding wheel industry to-day. These consisted of three types.

The first, *aluminium oxide* (principally used for grinding steel), was obtained from a raw material called "bauxite," a soft clay-like mineral containing 60 per cent. aluminous oxide. After being mined, the mineral is roasted or calcined in rotary calciners, thereby increasing the alumina content from 60 to 75 per cent. without fusion. The next operation was fully explained and dealt with the actual fusing of the material at 2,100 deg. C., producing ingots of 6 to 7 tons per furnace run. This electrical fusion had the effect of increasing the alumina content to 95 per cent. The material was then crushed by drop weights to pieces of one foot cube and imported to this country. A further series of crushing operations at the English works resulted in reducing the grain to sizes commonly used to-day, which range from six grains to the lineal inch up to five hundred grains to the lineal inch. The product is marketed by the Universal Works under the trade name "Bauxilite," and is eminently suitable for grinding all high tensile metals such as steel and malleable iron.

The second abrasive to be described was *white Bauxilite*, which is made in exactly the same way as the Bauxilite, except that before the fusing stage the aluminium oxide is purified by treatment with caustic soda; this operation has the effect of increasing the alumina content from 95 to 99 per cent. This abrasive is exceedingly cool and free-cutting, and is suitable for grinding exceptionally hard types of steel.

Silicon Carbide

The third abrasive to be described was *silicon carbide*. The Lecturer explained that the material consisted of high-grade silica sand, high-carbon coke, sawdust and common salt. The mixture was fused in a firebrick furnace at a temperature of 2,200 deg. C. The length of the furnace run is approximately 36 hrs. A current of approximately 125 volts and 6,000 amps. is employed. One of these furnaces will consume anything from 1,500 to 3,000 horse-power, so that it would be readily understood that the vast amount of electrical energy required could not be produced in this country at a price which would allow the material to be put on the market as a commercial proposition. Hence the reason why this particular material is made generally in Canada, France, Norway and America. It is the hardest artificial abrasive extant, and is suitable for grinding brass, cast iron, bronze, aluminium, marble and glass, and in fact all materials of comparatively low tensile strength.

It was explained that magnetic separators were used thoroughly to cleanse the grain before being put into use. A detailed account of the manufacture of the vitrified, resinoid or bakelite, and rubber bonded wheels was then given.

Bonding Methods

In dealing with the vitrified bonds it was pointed out that these consisted mainly of clays, felspars and fluxes, and that by changing the amount and nature of the materials it was possible to produce any required hardness of wheel. Bonding materials, after being carefully selected and tested, were reduced to the necessary fineness in mills, after which the bonds were carefully blended in special type "blungers." Two processes were fully explained: (1) The wet or puddled process, and (2) the dry press method. Lantern slides were used to illustrate detailed operations of both these processes, which result in producing wheels of a consistently uniform character.

After the pressing operation the wheels pass through the final drying room, packed in saggars, and proceed to the kiln house. Here the Lecturer explained the latest method of firing grinding wheels, which was by means of tunnel kilns approximately 200 ft. long, fired by producer gas, and fitted with the latest type of automatically operated temperature recorders, which made it possible to keep a thorough check on the whole process.

Resinoid-process wheels were then explained. It is possible to operate this type of wheel at running speeds of 9,000-9,500 surface feet per min. with perfect safety, and for this reason it was more than ever necessary to be absolutely accurate so far as balance is concerned. Mixers and presses exclusively designed and introduced to this process ensure that the structure of resinoid bonds can be controlled at will to give the best results for the type of grinding for which they are required. After pressing, the wheels are stoved at a comparatively low temperature in ovens for a period up to three days.

Rubber-process wheels were described and every operation dealt with in detail. The bonding materials consisting of a mixture of smoked rubber and other ingredients are masticated on steam-heated mixing rolls. The abrasive is introduced in the next operation, after which the material is passed through steam-heated calendar rolls to the required size. Thick wheels are built up in layers, laminated under presses, and vulcanised. A description of the method of truing up was given.

Mounting Grinding Wheels

The Lecturer then dealt with the question of correctly mounting wheels, explaining that side plates should be of the same size, and, generally speaking, should be half the diameter of the wheel. Steel plates should be used rather than cast iron, and the inner or driving flange should be keyed to the spindle. Blotting paper or thin rubber or fibre washers should be placed between the side-plates and the wheel, and the side-plates should be recessed slightly so as to ensure that the wheel is properly gripped, thus obtaining a true bearing on the periphery. Before a wheel is actually mounted, the spindle speed of the machine should be carefully checked to conform with the wheel makers' speed recommendations as shown on the tag on the wheel. A simple precaution which is frequently omitted is that of ringing the wheel before mounting to ensure that it has not been damaged in transit.

Illustrations were shown and explanations given of the correct method of dealing with large hole wheels and ring wheels. With the latter, it was emphasised that it is most dangerous to put undue pressure by grinding on the sides of flat, straight wheels, and that if side grinding is to be done, a ring wheel is the type of wheel to use.

Dealing with balancing methods, the Lecturer explained that the method of balancing by means of lead inserts was gradually being eliminated in favour of a new method, which consisted of spreading the out of balance limit in correct ratio from the periphery of the wheel to the bore, so that the wheel wears down in balance.

Foundry Applications

The Lecturer then dealt with the application of wheels to the foundry industry, explaining that when costs are under consideration, fettling wheels are apt to be judged on life and price, and not by a careful study of wheel wear as against removal of metal, and while it was unwise and extravagant to select a wheel that wears down excessively, it was true that a wheel which wears reasonably fast will so increase production and reduce the labour overhead and power cost per unit, as to be the most economical wheel to use.

The choice of wheels to give the most economical results therefore should be a careful study, and the selection should be the best possible wheel for the particular type of grinding it has to do.

Aluminous oxide wheels should be chosen for grinding castings of carbon steels, alloy steels, stainless steels, annealed malleable iron and tough bronzes, whilst silicon carbide wheels should be selected for fettling materials of low tensile strength, such as grey iron, unannealed malleable iron, chilled iron, brass, soft bronzes, and aluminium or aluminium alloys.

All other things being equal, the selection of the grade or hardness of a wheel can be simplified by following the general rule that the harder the material to be ground, the softer the grade of wheel required.

The Lecturer then dealt at length with the respective merits of slow speed floor grinders as against the high speed floor grinder, explaining that the latter, mounted with resinoid wheels and operating at the speed of 9,500 surface feet per min., was capable of producing far greater output owing to the fact that the cutting edges of the wheels were meeting the work at 50 per cent. greater speed. Furthermore, the latest type of high speed fettling machine was fitted with a mechanism which provided compensation for loss of wheel speed as the diameter was reduced, thereby retaining a high point of efficiency throughout the life of the wheel, this being a feature which was rarely available on the old type floor grinder.

Types of Machines Available

The high speed swing frame grinder was the next illustration of definite progress in foundry equipment; designed to run at 9,500 surface feet per min., the use of this type of machine is rapidly extending to-day. By comparison with the vitrified slow speed wheel, the Lecturer explained that a recent test had proved the high speed wheel to give 2½ to 3 times greater output for the same size of wheel. Another important point in connection with high speed floor grinders and high speed swing frame grinders was one which is inclined to be overlooked. Operators experience far less fatigue on these types of machines, and where any form of piecework is paid the fast cutting wheel must be an advantage to both employer and operator. The Lecturer explained that the efficiency of high speed wheels is dependent entirely upon the condition of the machines, and stressed the fact that great care and attention must be paid to their maintenance.

High speed portable grinders have proved extremely popular in modern foundries, but it was pointed out that care should be taken that no other than high speed wheels should be mounted on machines of this type.

Disc surface grinding was explained, and illustrations of the resinoid bonded discs in operation on 53 in. dia. machines were shown, it being readily realised that this type of disc can cope with multitudinous types of components, without the necessity for expensive jigs and work-holding attachments. Further application of surface grinding by discs was shown in an illustration of a twin disc machine, where valve springs can be traversed between the discs auto-

* A report of a Lecture given to the Lancashire Branch of the Institute of British Foundrymen, Mr. H. V. Grundy presiding.

matically; it was explained that on the very latest duplex machines a working tolerance of 0.0002 in. can be obtained.

Surface Grinding

Some foundries are equipped with surface grinding machines, and illustrations showing the method of the construction of a segmental head 18 in. dia. holding 10 segments 6 in. long was shown. Illustrations of the application of these segmental grinding wheel heads operating on automobile cylinder blocks, chain drive covers, etc., were given. Rotary table type surface grinders were shown, proving that where stock has to be removed quickly and commercial finish only required the segmental head was a most effective method to use.

Cutting-Off Machines

The possibilities of the high speed cutting-off machine were then dealt with in detail, and compared with the old type method of sawing metal, which was a particularly slow process. It was explained that with the high speed resinoid cutting-off wheels actual cutting time was reduced to a matter of seconds, and accurate lengths and ground surfaces could be obtained. High speed cutting-off machines were being introduced into foundries for cutting-off gates and risers, and were proving very successful. Cutting-off wheels, it was explained, were made also in shellac and rubber bonds, and with the latter type it is possible to produce wheels as thin as 0.006 in., which were used for slotting or grooving precious metals where it is essential to waste as little material as possible. The Lecturer suggested that the possibilities of the cutting-off wheels had not yet been fully extended, and one could visualise even greater progress being made in the near future.

The high speed cutting-off machines call for particular care and attention to bearings to prevent undue vibration which would result in poor performance and high cost of production. Many cases of wheel breakage, angle cuts, and burning of work can be traced to faulty machine conditions, such as weak, sprung, or loose spindles, poor machine foundations, uneven or slipping belts, insufficient power, etc. The Lecturer finally finished with a description of grinding wheels as applied to plate glass and cut glass industries.

Vote of Thanks

Mr. A. L. Key (Manchester) proposed that a hearty vote of thanks be accorded to Mr. Bromage for his address. Some little time ago he (the speaker) had occasion to take up the question of grinding mainly with regard to the life of grinding wheels. Formerly, one had to be satisfied with five weeks' life from a grinding wheel, but nowadays it was considered to be a bad wheel which was not capable of doing five months' work. There was now a better cutting speed, and consequently much more work done. On the other hand, the wheels cost twice as much as was formerly the case.

Relative Costs

Mr. J. Masters (Shrewsbury), in seconding the vote of thanks, remarked that the cost of wheels was not high when contrasted with the cost of production. He had seen some of the very fine cut-off machines in operation. Upon one occasion he had known saws of various manufactures to be recommended, but it was subsequently found necessary to return to the use of the grinding wheel. There was no comparison at all between them with regard to life. The cost of the saw was rather more than that of the wheel, but 50 times the life was obtained from the wheel, and that was simply for cutting off cores made from oil-sand. There were many ways in which grinding wheels could be applied in the foundry industry, and people ought to investigate more fully into the possibilities of their use.

Mr. Bromage, in acknowledging, said that the size of the factory at Stafford had actually been doubled during the past few years. This was partly due to the fact that foundrymen generally were now taking a more intelligent interest in grinding problems. At the same time, his firm were merely grinding-wheel manufacturers, and could not pretend to be conversant with modern experiments in foundries so far as new alloys or materials were concerned which were likely to be introduced from day to day. Nevertheless, if foundrymen would continue to present their problems with regard to grinding new alloys or materials, he, personally, would do his best to smooth away any difficulties. His firm would also be very glad to welcome any foundrymen who cared to visit their works, which were entirely British.

Regarding surface grinding, chemists had produced a high-porosity wheel in which the bond was so openly constructed that it was possible to blow smoke through it, although the grit size in this particular instance was as fine as 120 grains to the lineal inch. The result made it possible to obtain very deep cuts without undue generation of heat. The introduction of White Bauxilite material had considerably assisted the grinding of both cast iron and steel, this being due to the fact that White Bauxilite material had a very cool friable cutting action.

DISCUSSION

Elimination of Hand Sawing

Mr. Norman Cook, B.Sc. (Manchester), said that a difficulty in both large and small brass foundries was that there was so much work which had to be sawn off with a hand saw. Was it likely that there would be a machine put on the market which would saw off small pieces as is now done by grinding wheels? Work which had to be done by means of a hand saw was a very laborious process. In the case of aluminium, of course, it was quite easy to saw the metal with an ordinary wood-working band saw; but was there any machine on the market, or likely to be on the market, with some sort of tilting table and clamp to bring the work against the machine to saw off gates and risers from castings of quite considerable size? As a matter of information, why were not dynamic balances used on the wheels instead of balancing them by hand?

Mr. Bromage said that there were definitely cutting-off machines on the market as referred to by Mr. Cook. People were handling such machines in the Manchester district.

Mr. Norman Cook said that the ordinary falling gate cutter was not very satisfactory.

Mr. Bromage said it was necessary to have the tilting table with special clamping arrangements to deal with the cutting of gates and risers of awkwardly shaped castings.

Mr. Norman Cook agreed they would require special clamps.

The President (Mr. H. V. Grundy) said his firm used band and hack saws, together with gate cutters, for ordinary work. They had also used bakelite-bonded wheels, for cutting manganese bronze. This enabled them to cut through a riser 4 in. by 3 in. in 1½ mins. A fair amount of time is involved in setting up, but the process was considerably quicker than with the power hack saws.

Mr. Norman Cook remarked that the great objection to the gate cutter was the large amount of material still remaining, namely, something of the order of 10 per cent. on small work.

Mr. Bromage said that the cutting-off machine certainly had limits where large varieties of work were concerned.

Balancing Problems

Mr. Norman Cook said there were dynamic balances on the market.

Mr. Bromage agreed that there were dynamic balances on the market, but his firm had not found a type which had been sufficiently successful in production.

Mr. J. Masters inquired what limit of balance was specified.

Mr. Bromage said that it varied according to the type of wheel put through.

Mr. J. Masters asked if a percentage was specified.

Mr. Bromage said they were limited by the Home Office regulations as to how far they could balance. They could not put too much lead into the wheel.

Testing Conditions

Mr. E. Longden (Manchester) asked whether Mr. Bromage could give any information with respect to the silicon-carbide material in regard to the percentage of carbon and silicon as apart from the bonding ingredients. With regard to the bond—the bakelite—in the grinding wheels, Mr. Bromage had stated that the wheels were tested at 50 per cent. above maximum speed. Was the test made under load, or was it merely a test at rated speed without loading the wheel with a work piece, because a work piece could vary in size and weight, and the pressure by the operator could vary. A great deal depended upon the type of man using the work piece.

With regard to the tensile strength of the material, a little further explanation would be appreciated as to the reason for the different grits as against the tensile strength of the material. It was to be borne in mind that if the heat conductivity of the material was of a varying order, there might be a congestion of the abrasive wheel. He would like to know whether the heat-conductivity had been a matter of serious study. Probably it had, in view of Mr. Bromage's wide experience of the abrasive wheel.

Mr. Bromage said bauxite was to be found in Scotland, but the main factor preventing the manufacture of various artificial abrasives in this country was the impossibility of obtaining cheap power. He had not got the actual relative percentages of carbon and silica put into the furnace, because they varied slightly. The theoretical figures were 70 per cent. silica and 30 per cent. carbon.

Mr. E. Longden said that the silicon carbide ingredient was very important. It was the ingredient of most abrasive wheels.

Mr. Bromage replied that his firm did not actually produce the abrasive. It was made for them, and although tests proved that they varied very slightly, these did not have any detrimental effect on the cutting qualities. He regretted that he had not the actual figures with him.

With respect to the tensile strength relative to the grain, experience had proved that the harder the material to be ground the softer the grade of wheel should be to grind it, and, of course, *vice versa*. That was the general practice. The higher the tensile strength, the softer the wheel. This was the generally accepted principle in approaching any job.

Bursting of Wheels

Mr. A. Sutcliffe (Bolton) asked whether Mr. Bromage could give any explanation for the bursting of an ordinary emery wheel, 18 in. in diameter. In his works they had a stone for wet-grinding which was 14 in. on the face. On one side of the stone, 3 in. down, it always had a soft part. As the wheels were baked, would the soft place be on the upper or lower surface as related to the position in the kiln? Would it be better to make two stones of 7 in. each and dovetail them in some way to couple them up? In the case of one particular stone, after it had been running about two or three years, it developed a zigzag crack. Could Mr. Bromage say what would be the cause of it?

In the turning shop they still used two ordinary quarried stones. When he asked one of the men whether the newer type of stones would not do better, he was told it would not, as it kept the tools cool during grinding. The tools commonly ground on this wheel included drills, chisels and those used by the turners and patternmakers.

Causes Detailed

MR. BROMAGE thought the question of why the 18 in. by 3 in. wheel burst could only be dealt with by the people who had actually witnessed the conditions at the time of the breakage. He could state several causes which would bring about a breakage. A very common cause was, as he had already explained, by using flat plates without washers and screwing them too tightly on to the spindle. Directly the machine was put into motion the centre would probably burst clean out of the wheel, because it was being held merely in one point. The whole of the weight of the wheel would be pushing itself against the centre, and it would eventually force out the centre. That was one thing which would definitely cause a breakage without putting any work piece on the wheel at all.

Another common cause was the fitting of dovetailed plates on to plain wheels. Yet another common fault was the underplating of the machines; that is, a 6 in. plate was put on to an 18 in. wheel, or a 9 in. back plate and a 4 in. front plate. Uneven plates would cause the breakage of a wheel. There were dozens of other causes.

Speed, of course, was another great factor. He had inspected wheels which had been running at twice their normal speed, and both operators and managers had been most surprised at his conclusions. In the case of the portables referred to in the lecture, there were 20 odd machines working at the time, and everybody was ignorant that the machines were running at 10,800 surface ft., and they had been doing so for months. The firm had never been allowed to see the machines before until customers complained of lack of cutting power.

He was afraid he had missed answering a point mentioned by Mr. Longden concerning what a wheel would actually do. The firm did not actually test them against work at all, but ran the wheels freely at 50 per cent. over normal speed, which involved vitrified wheels running at 10,800 revolutions a minute. They were obviously on the right side of the safety margin. He had often entered into discussions as to whether the two 7 in. cemented wheels were better than one solid 14 in. wheel. He had come to the conclusion that there was a great deal to be said in favour of both types. If conditions were absolutely ideal in regard to manufacture and running or operating, he thought the balance was in favour of the 14 in. wheel. If a wheel was correctly pressed and correctly fired in one piece, with even top and bottom firing, then, given correct operating, there was no reason why there should not be correct action right throughout the life of the wheel, provided the correct speed was maintained.

Provided there were correct firing conditions, then two 7 in. cemented wheels could give really good service. Personally, he preferred the 14 in. face wheel in one piece.

He could not state any reason for a wheel cracking zigzag right down the centre, unless it had not been properly fired. Wheels were built up in layers at pressures which were all predetermined. All he could say was that the wheel was probably not correctly fired in the centre; but, of course, he was speaking without having actually seen the wheel. A really good natural stone for ordinary tools would take a lot of beating, but for one good natural stone one would be likely to get ninety-nine faulty ones. Then, again, one was confronted with the Home Office regulations respecting the Silicosis Act, involving the emission of free silica.

MR. E. LONGDEN remarked that the silicon carbide material would frit at only a very high temperature.

MR. BROMAGE replied in the affirmative. His firm, however, were not actual producers of silicon carbide.

Cut-off Machines

MR. J. A. REYNOLDS (Prescot) referred to the cut-off machines. It seemed to him that the problem was to obtain the necessary depth of cut, or depth of wheel, on to a riser which might not be in the top edge of the casting. Even with a tilting table it was not possible to cut off a 6 or 7 in. riser if that riser happened to be in the centre of a casting which was perhaps another 6 or 10 in. from the edge.

Another point he wished to raise was with respect to the disc-surface grinder, which was shown on a slide as grinding, he thought, some electrical cable boxes. Would it really remove material comparable with the Lumsden type surface grinder, or the "Snow" ring type? Was it better, or was it slower?

With regard to the high-speed bonded type of wheels, he took it that it was necessary to have a specially strengthened machine with heavier bearings, and also a heavier column and base, to withstand the high-speed and higher vibration set up. Was there a special wheel for grinding soft high-conductivity pure copper? In a foundry where there was a considerable variety of work, say aluminium, aluminium-bronze, manganese bronze, gunmetal and brass, it was found that one difficulty with regard to copper was that it was apt to clog the wheel. Was it worth while having a special wheel for copper?

Non-Slipping Floor Plates

His last query was rather outside the question of grinding wheels. He had been experimenting with the making of floor plates for use in the factory, in order to get a non-slipping medium and a hard wearing surface. An attempt had been made to imitate an American process of casting an abrasive grain into the surface of the iron. It was thought they could use some of the old silicon-carbide wheels ground up. Despite using hot iron, and employing several methods of binding the abrasive grains to the sand, such as the use of silicate of soda, core oil, etc., they did not quite succeed. They did not seem to be able to frit the grains on to the surface of the iron. He wondered if it was a mistake to use silicon carbide, which he expected had a higher melting temperature, and that they might possibly have succeeded if they had used bauxite or the aluminium oxide type of abrasive.

Limitation of Cut-off Wheels

MR. BROMAGE said that the high speed cut-off wheel had its limitations. If a riser was in an awkward position then even with a tilting table and a clamp there would be difficulty. Discs had a cut equally as good as the ring or planetary type. He should say that they cut equally as fast, but they did not remove more metal. There was more chip clearance, but there was not the same life that there was with the planetary type. It was open to question whether a disc would be more economical when cutting down to fine limits. If it was a question of moving the metal he thought discs were best. They would turn off a surprising amount of metal very quickly.

It was necessary to have special machines for high-speed cutting. The bearings had to be strengthened, and there had to be a special base, as well as a sufficiency of weight and rigidity. One must not try high speed grinding on the ordinary type of machines or there would very soon be trouble.

He wished to be perfectly frank. He did not think there was any wheel which would grind copper only without clogging. The firm had special wheels for dealing with copper, but there was always that tendency to clog. While they had very nearly reached perfection, he would certainly advise cleaning the wheel by using it intermittently on other metal.

With regard to non-slip materials, he did not think any better result would be obtained if Bauxilite was used with the iron. If Mr. Reynolds had not succeeded with the silicon carbide he would not do so with Bauxilite. The firm made a non-slip material, but it was purely with the abrasive and ordinary clay.

Nature of Bonds

MR. E. LONGDEN asked whether, grit for grit, Mr. Bromage would agree that vitrified material would take off material much more quickly speed for speed than grits bonded with other material such as bakelite.

MR. BROMAGE replied that the grits used in both types of wheels were similar. The vitrified portion was the bond, not the grain.

MR. E. LONGDEN said that he gathered that the bonding was done with different materials. In one case with bakelite, whilst in another by high temperature.

MR. BROMAGE replied that with high speed it was bakelite bond, while in the other type it was ordinary china clays which when fired at high temperatures held the grains together. Actually, the grains in both instances were similar.

Reducing Waste with Disc Wheels

MR. A. E. BYRON (Prescot) observed that there was a large amount of waste in connection with the use of a disc wheel. A 10-in. wheel with 8-in. plates when worn down to the plates was 8½ in. Thus his practice was then to put on 6-in. plates and re-use to practically 6 in. Finally he used up the remainder on a portable grinder, taking a 6-in. wheel. Normally the waste of material was more than that actually used.

MR. BROMAGE agreed, and that was why he emphasised the necessity for the wheel being properly operated. Many operators ground with a disc in one position only, instead of moving the work right across the face.

MR. REYNOLDS asked whether with Mr. Byron's system the wheel would run less efficiently at the smaller diameter and at the same speed.

MR. BROMAGE said wheels losing diameter consequently lost speed and were bound to lose their cutting efficiency, and to maintain the correct efficiency the wheel speed should be increased at various stages throughout the life of the wheel. With a 24-in. wheel the speed should be increased at, say, 22 in. and 17 in.

MR. ROWLAND replied that they varied, but he thought 24 in., 22 in. and 17 in. were usual.

Economies Introduced

MR. R. LAROUX HANDLEY said the lecturer had given the maximum safe speed for vitrified wheels as 6,000 surface ft. per min., and for the new bakelite-bonded wheels as 9,000. He had said that the cutting speed was proportional to the speed of the wheel. That meant that the modern high-speed wheels should show at most an improvement of 50 per cent., or rather less if handling time were taken into account. A number of manufacturers had cited cases to him where users of high-speed wheels had obtained increases in production of from 100 to 200 per cent. Could Mr. Bromage explain this?

MR. BROMAGE replied that an increase from twice to three times was a big percentage. It could be accounted for, in great measure, by ease of handling, and the speed with which a job could be got rid of. A test was made recently when double the amount of work was obtained in a steel forge with high-speed wheels owing to ease or quickness of handling. The metal could be moved much quicker, and there was not the personal fatigue as when using a slow-speed wheel.

PEGLERS, LIMITED, metal founders, of Doncaster, propose to distribute a 50 per cent. scrip bonus to "A" and "B" ordinary shareholders by capitalising £55,787 of undistributed profits and paying up in full 233,150 "B" ordinary shares of 5s. Shareholders, state the directors, should not anticipate the maintenance of the same rate of dividend (33⅓ per cent.) on the larger capital. The authorised capital is to be increased from £190,000 to £250,000 by the creation of 240,000 5s. "B" ordinary shares.

Care and Maintenance of Control Instruments

By D. T. ANDERTON, B.Sc.(Eng.)

The urgent demand for efficiency in industry has led in recent years to a rapid application of scientific instruments to industrial processes. Analysis of accurate measurements is recognised as essential in order to check any extravagant use or wastage in the generation, transmission or transformation of power, and also to ensure the operation of industrial processes under the optimum conditions. The result of this wider appreciation of the interdependence of efficiency and accurate measurement has been the installation of increasing numbers of measuring and controlling devices in up-to-date works. After installation comes care and maintenance, since instruments cannot be expected to function at their best if they do not receive regular and careful attention. The literature on this aspect of instrument application is quite scanty, and it may therefore be useful to offer some hints in this direction.

Mercury-in-Steel Thermometers

One of the most important classes of control instruments includes those used for indicating and recording temperature. In the first place, considering the indicating part of the instrument, this may be sub-divided into four types, represented by mercury expansion thermometers, thermocouples, resistance pyrometers and radiation pyrometers. Only the first three will be discussed here, since radiation instruments, when needing attention, should be returned to the makers.

The mercury-in-steel thermometer is particularly suitable when dial indication of the temperature is required, and this type of instrument has a certain advantage in being independent of electrical circuits. The amount of the mercury expansion is measured by means of a Bourdon tube gauge. Usually the tube of a well-made gauge is very reliable and may be used for years with confidence. If slow recording of sudden temperature changes is suspected, it will be advisable to check over the capillary tubing for possible kinks or bends. Repeated kinking may cause breakage of the capillary. Wear and corrosive attack of the capillary tube caused by moisture, fumes, or both, are well worth checking with an occasional coat of paint, since the accuracy as well as the life of the instrument may be seriously affected by a rusty tube.

Mercury leakage will be shown by the level falling below the lowest reading on the scale; this will necessitate return of the instrument to the makers for repairs—it should *not* be patched up in the shops. It should be remembered that lubrication with a little clock oil will assist the gauge mechanism. Calibration is best effected by comparing the readings with those of a mercury thermometer which is placed near the bulb. The best instruments of this type cannot be expected to have a greater accuracy than about 2 per cent. of the reading.

Thermocouples

Owing to the minute currents involved, temperature measurement with thermocouples is a delicate business. These instruments must therefore be carefully installed and used. All terminals and switches must be kept clean and the wiring in good condition, so as to eliminate as far as possible any parasitic currents or added resistance. Where a recorder of low internal resistance is in use, it is essential that good contacts and a close check on the resistance of the circuit be maintained.

Having seen to this, attention should next be given to the sheath and the thermocouple. Any tendency to failure of the insulation at the head of the couple should be counteracted by protecting it with asbestos rope. The silica sheath should be examined periodically for leakages, as silica exposed to high temperatures (1,000 deg. C. and over) for prolonged periods tends to become brittle and pervious to gases. This is particularly dangerous in the case of rare-metal couples, since these couples are attacked by furnace and reducing gases. Danger of breakage of the sheath by accidental blows or due to sudden temperature changes is best provided for by placing an iron tube around a silica or porcelain sheath.

The thermocouple itself requires periodic examination for deterioration and should be regularly checked or calibrated. Calibration may be effected by comparing the readings given by the couple with those of a standard thermocouple when both are placed in the same bath of molten metal. Good metals to use are tin and lead, but it should not be overlooked that the couples will need protection with an iron or silica sheath when immersed in such a bath of metal. The method is to immerse the protected couple in the cooling metal and to observe the point at which the reading halts on its downward path; this is the solidification or melting temperature of the metal, and the actual figures may be obtained from various standard works of reference. A series of such observations will give a calibration curve.

Occasionally, a single measurement of this kind is all that is required when the behaviour of the couple needs checking only in one particular range. Sometimes it is desired to calibrate or check a couple in position. This is due to the fact that working conditions may influence the homogeneity of a couple and result in slight variations from a laboratory calibration. In this case it is usual to place the junction of the standard couple as near as possible to that of the couple under test—if possible in the same sheath. In any case, checking should be carried out at several temperatures, but the test should not be made too elaborate, owing to the variability of local conditions at the couple junctions in this situation.

It is also useful to check the resistance of the circuit periodically with a test outfit of the Wheatstone bridge type. For this, the recorder should be disconnected and the resistance of the leads and couple found by connecting the leads both ways and averaging the results. If this is higher than that for which the recorder was designed, then the line at the cold junction should be short circuited. It will then be seen whether the trouble is in the line or the couple. A short circuit in multi-installations is quite likely if there is a common return wire. A power circuit leakage would also affect every couple equally in an installation of that nature, and would therefore be difficult to detect.

Resistance Thermometers

Similar remarks regarding clean contacts and wiring may be made in the case of resistance thermometer installations. In addition there is an external battery to keep in order, but in these days of wireless and the ubiquitous motor-car it should be unnecessary to discuss this. When an instrument of the electrical resistance type is suspected of giving inaccurate readings it should be inserted in a vessel of water with a reliable mercury thermometer. The reading will then be found to be too high, too low or unsteady. The trouble in the first case is too great a resistance in the circuit, and investigation will usually reveal a bad contact somewhere, which can soon be remedied. In the second situation the most probable explanation is a short circuit, since the resistance is too low. It may be located at the porcelain head of the thermometer and/or at points on the wires and coils inside the sheath. It may be due to moisture and dust settling at such places and thus serving as a shunt across the wires. The trouble is corrected by cleaning and drying the affected parts. The third trouble is usually caused by a partly-broken or loose connection. In the former case the damage should be repaired by solder, though it is advisable to send the thermometer back to the makers for repairs if the damage is inside the coils themselves.

Electrical Instruments

Electrical measuring and recording instruments for temperature and other variables are particularly advantageous, in that it is possible to have an indicator at one point and a recorder some distance away at a more convenient place. Several measurements may be recorded at one and the same place, and if necessary the recorder can be kept operating while the indicator works only when switched on as required. Recording instruments of the electrical type are very widely used to-day, but they operate most efficiently when numerous little details of operation receive regular attention.

In the first place, the ink needs careful consideration. When two or more records are taken on the same chart it is often convenient to have these in different colours. In this case the inks used must be such that they will not run together if the records cross. The ink should also be non-corrosive to the pen. It follows from these points that ordinary ink should not be used on a recorder, otherwise rapid corrosion will follow.

When thread recorders are used the threads are already inked with a hygroscopic (*i.e.*, moisture retaining) ink, so that when the records from this type of instrument become faint it is a sign that the apparatus needs a new thread and not re-inking of the thread with ordinary ink. The latter will tend to dry and will also interfere with the operation of the thread rollers. Renewal of threads will, of course, be more frequent in hot dry atmospheres.

Recording Charts

Another important point is the quality of the paper from which the recorder chart is made. The necessity of selecting inks which do not run when records cross has already been pointed out. This precaution will be useless if the paper is so absorbent that the ink runs and forms "blotchy" lines. At the same time, the paper should be sufficiently absorbent to allow the ink to dry in a reasonable space of time. The surface of the paper should also help to minimise friction, a slight glaze being advantageous for this purpose. It is in elimination of such friction effects that devices such as the chopper bar and an ink thread are so useful. It is evident that the paper should be well and clearly marked, otherwise the accuracy of any records obtained may be impaired. The humidity of the surroundings sometimes influences the dimensions of a chart, and therefore the accuracy of readings, and some instruments have devices to compensate for this.

(To be concluded.)

Indian Pig-iron Exports

Exports of pig-iron from India during the first nine months of the current financial year, from April 1, 1938, to December 31, 1938, totalled 360,162 tons, as against 464,111 tons during the corresponding period of 1937. Exports to Japan increased from 215,552 tons to 226,475 tons, and to "other countries" from 15,455 tons to 64,227 tons. Exports to the United Kingdom declined from 177,430 tons to 65,329 tons, and to the United States of America from 51,761 tons to 4,131 tons. There were no exports to China during the period under review, as against 3,913 tons in 1937. Exports of scrap declined from 54,282 tons to 42,245 tons. Practically the whole of the trade was done with Japan, which took 41,519 tons, as against 54,136 tons.

Melting Practice in a Large Engineering Iron Foundry*

By W. W. BRAIDWOOD

The foundry concerned is engaged in the production of castings for steam-raising and general engineering purposes. The melting plant comprises four cupolas, each with a capacity of from nine to ten tons per hour; one cupola, melting four tons per hour; and an oil-fired crucible furnace, but this Paper will deal only with the operation of the larger cupolas.

The general arrangement of the foundry is illustrated in Fig. 1, and it will be observed that the cupolas are situated almost centrally. This feature is probably a departure from the orthodox, yet such a position, especially in a large foundry with a heavy daily melt, may be claimed to possess the following advantages:—

(1) The "spout to mould" time interval approaches equality in all instances.

(2) Return of floor scrap to the charging system is rendered more easy.

(3) Melting plant accessory equipment may be utilised to a greater extent.

The latter point probably requires elaboration. In the present instance, the cost of construction of the very substantial charging platform made necessary by the technique employed is partially neutralised by utilisation of the main columns as supports for crane gantries in adjoining bays. Similarly, the overhead crane serving the cupola charging system is available for the handling of materials other than furnace requisites. Actually, the normal "spare time occupation" of this particular tool includes the handling of approximately five hundred tons of sand per week.

The larger cupolas, which are responsible for over 96 per cent. of the normal daily melt, are of the balanced-blast type, to the design of the British Cast Iron Research Association. They are normally operated as two units of two furnaces each, one unit providing the cupola which is in service throughout the entire working day, while a cupola from the second unit is in blast each afternoon. Each furnace, therefore, is in service only on alternate days, so that ample time is available for careful fettling between melts. Flexibility, however, is the keynote in their operation, and, in the event of a major breakdown or lengthy repair, the duties of all-day and of part-day melting can be allocated anywhere within the battery. These cupolas, all of which incorporate stationary, inert receivers, are of identical design, and are as shown in Fig. 2.

Underlying Principles of the Balanced Blast

The external appearance of a balanced-blast cupola is already familiar to most foundrymen, and the principal theory underlying its design is also generally understood. It may be re-stated briefly. When air comes in contact with incandescent coke, carbon dioxide is the product first formed. This reaction between oxygen and carbon is strongly exothermic, and great heat is generated. In presence of excess carbon at high temperature, however, the dioxide may be reduced with formation of carbon monoxide, an inflammable gas. This latter reaction is endothermic, a considerable amount of heat being absorbed. Actual heat values[1] may be quoted:—

1 lb. of carbon burning to form the dioxide, generates 14,550 B.T.U.

1 lb. of carbon burning to form the monoxide, generates 4,350 B.T.U.

1 lb. of carbon (as monoxide) burning to form the dioxide, generates 10,200 B.T.U.

In the older type of cupola, the monoxide so formed was left free to pass up through the preheating zone, and into the stack. Generally, the presence of appreciable proportions of carbon monoxide in the waste gases of an ordinary cupola is indicated by the presence of a bluish flame at the sill, where this gas burns on coming into contact with the oxygen of the air. The principal aim of the balanced-blast design is the complete combustion, within the cupola, of this inevitably-formed monoxide, with consequent improvement in the thermal efficiency of the furnace, and this is effected by the introduction, above the producer zone, of sufficient air to burn the monoxide to dioxide.

Articles[2,3] by well-known operators have already described this type of cupola, and controversies regarding the benefit, or otherwise, of such auxiliary tuyeres have been exhaustively waged. The present writer, as is his nature, was originally a sceptic, but now, after three years of experience with balanced-blast cupolas, operated during several months alongside orthodox cupolas of similar dimensions, the author, as may be judged by the form of his participation in a major controversy,[4] is a strong supporter of this particular type of recuperative cupola. There can be no doubt that the balanced-blast system constitutes a definite advance in cupola design, and, with understanding control, its economic potentialities are really considerable. In the opinion of the writer, however, the undoubtedly improved results associated with its use are not entirely, nor even principally, the product of the more complete combustion made possible.

Broadly speaking, the efficiency of a cupola is measured in terms of the temperature of the tapped metal. A recent preliminary investigation of the effects of operating one of the balanced-blast cupolas under the author's charge with various tuyere settings revealed that improvement in the efficiency of the process of combustion, as indicated by exhaust gas analysis, was not necessarily accompanied by increase in the temperature of the tapped metal. In fact, there was seen to be no direct relation of combustion efficiency with metal temperature, and the most definite indication yielded by this preliminary research was that, when conditions were such as might be expected to maintain a deep bed of highly-incandescent coke, the highest metal temperatures were obtained.

This finding has support in logic, since the prime factors determining the temperature of metal tapped from a cupola undoubtedly are "bed temperature" and "time of exposure." Therefore, it may be argued that, where a relatively deep bed is maintained, the temperature of each metal droplet, by reason of the longer time of exposure to high temperature conditions, is relatively more able to approach that of the heating medium.

It is in the light of this reasoning that the balanced-blast cupolas under the author's charge are operated. The principal aim is the economical maintenance, in a highly-incandescent condition, of a deep coke bed, this being accomplished by judicious distribution of the necessary air. In passing, it may be of interest to many operators of balanced-blast cupolas to learn that the tuyere settings at present very successfully employed in the cupolas under discussion are:—

All three rows of auxiliaries: Full open.
All main tuyeres: Half open.

The internal contour of these cupolas is a noteworthy feature, the taper from shaft to well being very pronounced. Calculations from the actual diameters, which are 66 in. and 36 in. in shaft and well respectively, show that the cross-sectional area of the shaft is 3.36 times that of the well. In the standard design of these cupolas, the latter diameter is quoted as 48 in.; this would give a ratio of only 1.9 to 1, which is more representative of the conventional. Maintenance of the pronounced taper depicted has proved to be a very successful method of improving the efficiency of these cupolas, and the theoretical advantages may be enumerated.

(1) The air is introduced nearer to the centre of the cupola cross-section. Consequently, more complete penetration of the blast across the bed should be obtained, thus promoting more regular combustion of the bed coke, and more uniform melting of each metal charge.

(2) The furnace gases pass from a narrow well into a relatively wide shaft. This may be expected to reduce the velocity of the ascending gases, and render more efficient the transfer of sensible heat from the hot ascending gases to the cooler descending materials.

(3) The required height of the coke bed is more economically obtained.

(4) The cost of lining wear is reduced.

As evidence in support of the second claim, it may be stated that the normal average temperature of the exhaust gases does not exceed 250 deg. C., while the coke saving referred to in the third paragraph is really appreciable, amounting to approximately 10 cwts. per bed, or 40 per cent. of that weight which would be required to give the desired bed height within a 48 in. diameter lining.

Fettling

This operation is carried out in a thorough manner at Renfrew, gauge sticks being used at each repair to ensure conformity with the contour shown. There is no doubt that such careful fettling pays a dividend by promoting uniform and safe cupola operation, and by reducing ultimate maintenance costs.

The condition of the lining of a balanced-blast cupola, after a long melt, can be a helpful pointer toward improvement in the method of its operation, and this general observation may be made. Localised wear, in the form of a distinct horizontal furrow, its centre about 24 in. above the level of the main tuyeres, may be expected when these are set in the fully open position. As the main tuyere openings are reduced, however, this tendency to produce localised erosion is correspondingly decreased till, with the tuyere settings normally in use, and already detailed, wear on the lower sections of the cupola lining becomes remarkably uniform, and really slight.

Costs are of particular moment when fettling methods are under review, and the following figures are probably of interest. Over a test period of four weeks' duration, the weight of material used at each repair following an all-day melt was carefully observed, and recorded, together with the metal throughput in each instance, and the ratio of purchased material to metal melted was found to be as 1 is to 105, the cost equivalent being 5.54d. per ton of metal melted. Lining wear on these cupolas melting for part of the day only is less, but not proportionately so, with the result that the overall cost of ganister per ton of the total melt is higher than in the particular instance quoted. Actual ganister cost for 1938, on a total melt of 30,166 tons, and using a high-grade material priced at 48s. 6d. per ton, delivered, was equivalent to 7.77d. per ton of metal melted.

(This figure, of course, includes those amounts of ganister employed for miscellaneous, and sometimes surreptitious, purposes throughout,

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. R. Ballantine presiding.

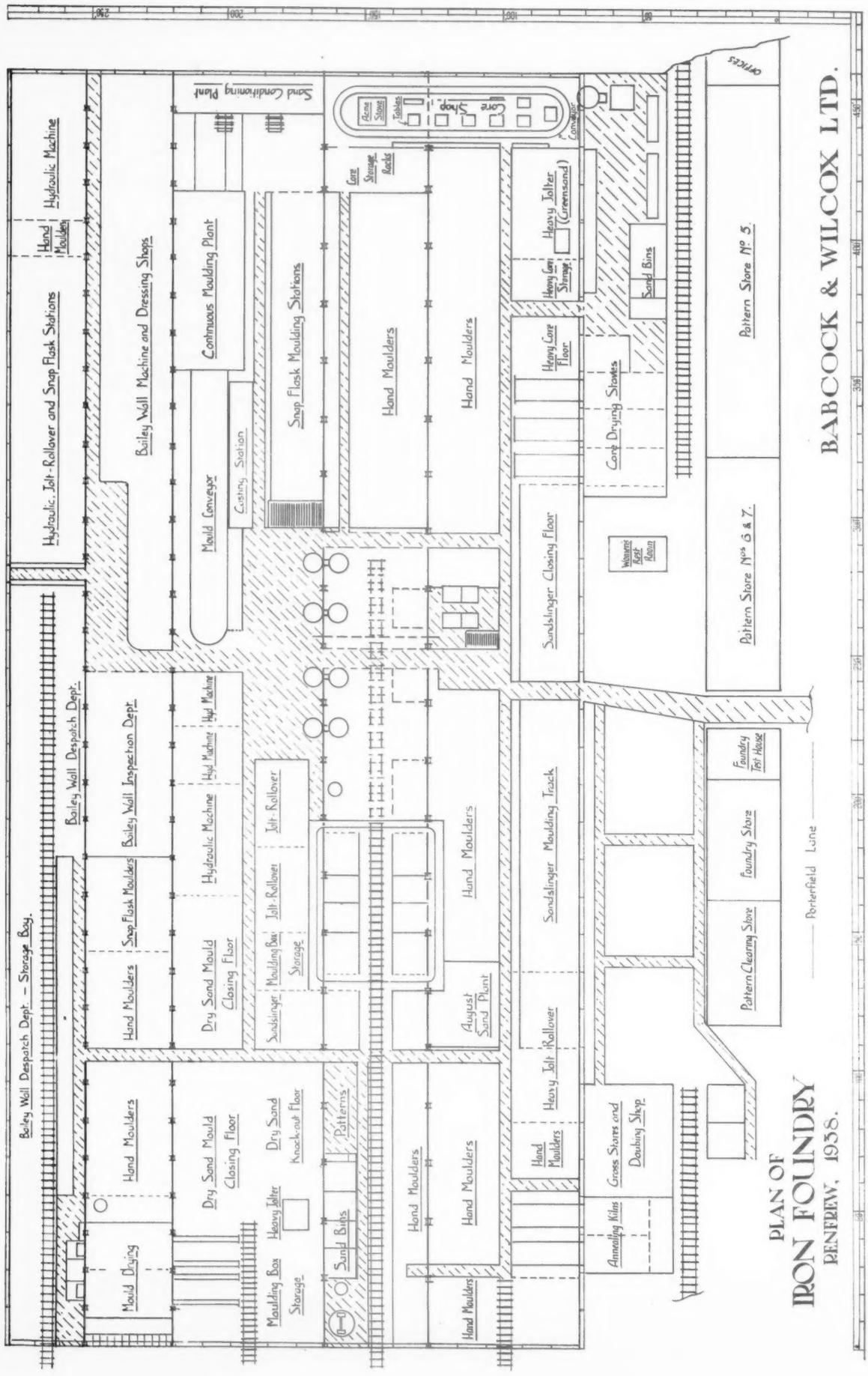


FIG. 1.—SHOWING THE LOCATION OF THE MELTING PLANT IN RELATION TO THE GENERAL LAYOUT OF THE FOUNDRY.

and conceivably beyond the confines of the foundry).

When fettling is complete, and the sand bottom carefully rammed, kindling wood is inserted, care being taken to place flat boards on the bottom, and against the walls, in order to protect those parts from injury. Exactly half of the necessary weight of bed coke is then dropped in, gently, by hand.

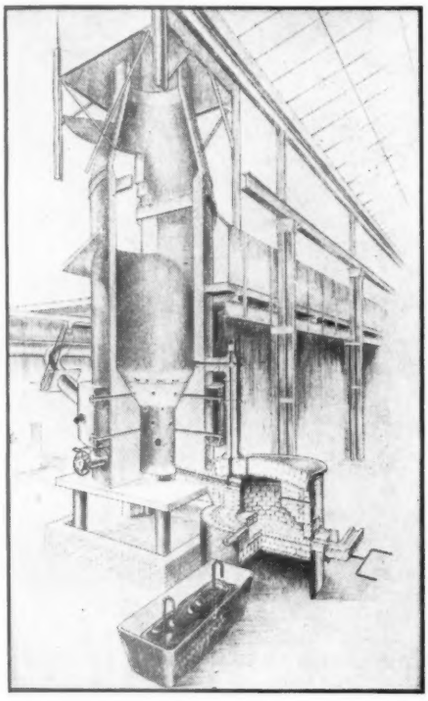


Fig. 2.—Sectional View of the Cupola and Receiver, together with the Method of Slag Disposal.

In the case of that cupola required to be in blast on the morning of the following day, the bed is lit in the late afternoon, and allowed to kindle freely for some 45 minutes. After this period, the back door is rammed up and covered, all tuyeres closed, and the bed left to burn very quietly overnight. This procedure has several advantages:—

(1) The patch is gently heated, initially, and is dry, hard and hot when the cupola goes into service.

(2) The furnace can be in blast next day in the shortest possible period of time.

(3) The bed eventually has a thoroughly incandescent lower layer which promotes rapid and uniform melting.

Receiver Practice

Opinion in foundry circles continues to be divided on the subject of hot-metal receivers. Generally, the disadvantages attending the use of cupola receivers are stated as under:—(*a*) heavy heat losses are incurred, and (*b*) maintenance is an item of considerable extra expense.

It has been stated that sharp separation of differing and successive metal charges is difficult where a receiver is in use, but, to the author, this claim has always seemed unreasonable. Mathematically sharp separation of such charges is never possible in any cupola, unless exceptional coke separations are employed, and the best that normally can be expected is a swift transition from the characteristics of one charge into those of the other. This is no more difficult though a receiver be interposed between furnace and outlet, since the receiver can be drained at such stages just as the cupola may. It is surely logical to claim, then, that this alleged disadvantage does not, in fact, exist.

Regarding (*a*), heat losses, though undoubtedly incurred, are not so considerable as is often imagined, and may be reduced, as at Renfrew, by insulation. Tests carried out on insulated and uninsulated receivers of otherwise identical design, operated under standard conditions, confirmed that appreciably hotter metal was tapped from the former type, while their shell temperatures were much reduced. The opinion of the writer is that heat losses in, and from, an insulated receiver have little practical effect once the temperature of the inner surface has been raised to that of the metal delivered from the cupola. The inference, however, that the metal first tapped must be very cold, should not be drawn. Actually, the temperature of the first-run metal is somewhat lower than the normal, yet this difference is slight, particularly in the case of those furnaces kindled on the previous evening, and there is no difficulty attending the disposal of this first metal. The usual procedure at Renfrew is to take the first thirty cwts. in a ladle for the casting of heavy section structural work, the succeeding metal being supplied, immediately afterwards, to the continuous-casting plant, for the pouring of stoker links of light section.

Concerning (*b*), it may be claimed that money spent on the maintenance of a receiver is in some respects a sound investment. Because of the immediate transfer of metal and slag to the receiver, wear within the cupola is reduced, and, as a matter of actual fact, cupola repairs, apart from the routine fettling, are observable at Renfrew mainly by their absence. The furnace last re-lined, at the time of transfer to its present situation, is still in perfect condition, after two years of service.

The special firebricks which form the runner from cupola to receiver, shown in Fig. 3, contain 42 to 44 per cent. alumina, and have an average life of 800 to 1,000 tons of metal melted. Renewal is a fairly easy matter, and is carried out without interruption of the melting sequence. Receiver bottoms are re-laid very infrequently, generally after total melts of 4,000 to 5,000 tons, while inner brick courses are good for twice that amount. The very useful segmented roofs are practically everlasting, and, altogether, the receivers in use, and as operated, are items of only moderate cost.

So much for the generally-accepted disadvantages of cupola receivers. What now, of the advantages associated with their use? They are:—

(1) Immediate removal from the cupola of its molten products dispenses with the necessity for providing storage space within the furnace proper. This permits of the main tuyeres being placed quite close to the cupola bottom, with consequent saving in bed coke. Furthermore, the safety factor is greatly increased, and the operator relieved of the necessity for constant watch on slag level within the cupola, while slag attack on the cupola lining is minimised.

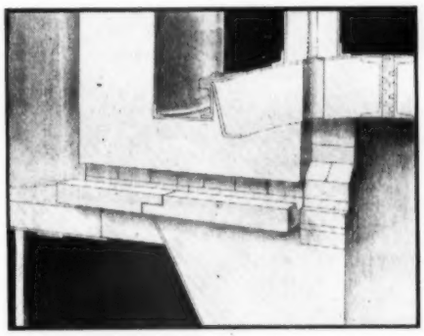


Fig. 3.—Details of Receiver Construction.

(2) The reservoir of molten metal which can be maintained within the receiver assists in ensuring tapped metal of uniform composition, while affording ample opportunity for the removal, by flotation, of non-metallic inclusions.

(3) With a tap-hole of suitable diameter, the receiver is enabled to provide a continuous flow of clean metal over long periods, thus dispensing with the need for frequent botting and tapping.

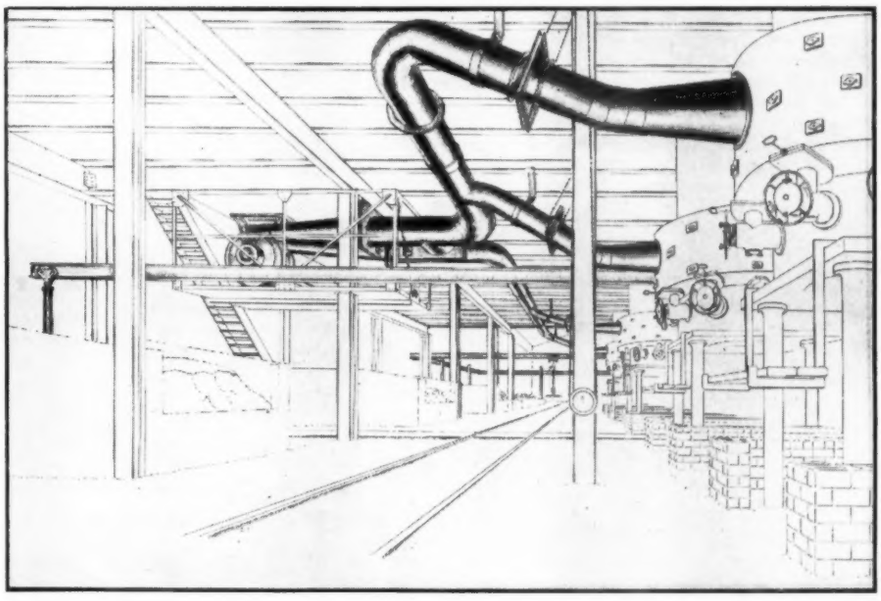


Fig. 4.—The Blowing Arrangements for the Cupola Plant.

(4) Relatively large quantities of hot metal may be accumulated for subsequent rapid tapping when heavy castings are required to be poured at high temperature.

(5) Slag removal is rendered an easy, infrequent, and thermally economical operation.

(At this juncture, it is difficult to resist the inclination to ponder whether those persons so conscious of, and emphatic regarding, the thermal losses attending the use of inert receivers realise how much heat, and metal, can be lost through the constantly-open slag notch which is a familiar feature of many foundries.)

The construction of the type of receiver in use is shown in Fig. 2. The runner is laid at an angle of 2 deg. to the horizontal, and a splash-block, built under the fall, protects the bottom from selective erosion at this part. The bottom consists of a single brick course laid on edge over a layer of silica sand approximately ½ in. thick. This facilitates removal when renewal becomes desirable. Below the sand is a double course of firebrick, insulated from the shell by a layer of compressed asbestos. The walls are built with an easily-removable inner course 4½ in. thick, backed by a further 9 in. of firebrick. Behind this is an insulating layer, 3 in. thick, with a further 4½ in. of brick against the shell. The slag notch is positioned 5 in. above floor level. The segmented roof is noteworthy, and of real value in rendering the receiver readily cooled and easily accessible when repair is necessary. The tilting launder is very effective, and of simple design, yet sufficiently familiar to need no further description.

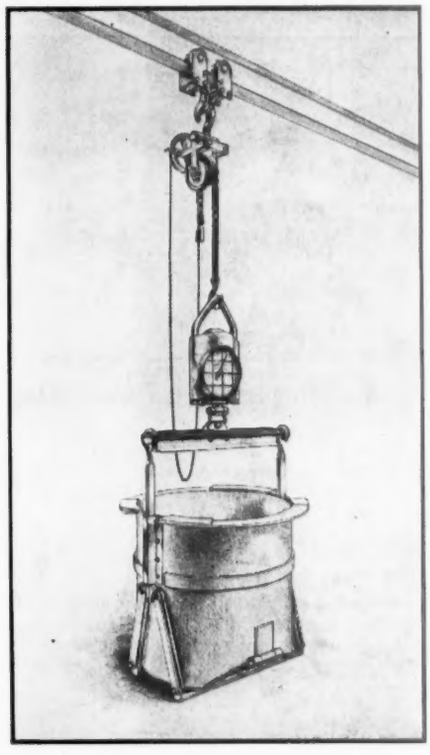


Fig. 5.—Type of Skip Used for Handling Charges for the Cupola.

Slag

The operations of slag removal and disposal are simple, clean and inexpensive, the apparatus being as shown in Fig. 2, and the procedure as follows:—

Between the two receivers of each unit a cast iron vessel, bath-shaped and of heavy section, is secured. In each bath a 6 in. deep sand layer is maintained, and into this a lifting bar, of the type shown, is set. At intervals of from 2 to 3 hours each, and when the receiver has just been drained of metal, the notch is opened, and the accumulated slag allowed to flow from the receiver into the bath and over the bar, the blast being interrupted for a few seconds only, during replacement of the bott. On cooling, the block of slag is withdrawn by overhead crane, and transported to the yard by electric bogie. There it is shattered by a blow from a heavy ball, and the pieces utilised in a scheme of land reclamation. Slag remaining in the receiver at the end of a melt is similarly collected, a sand-covered bar being set in a trough below the receiver breast, which is then burst open.

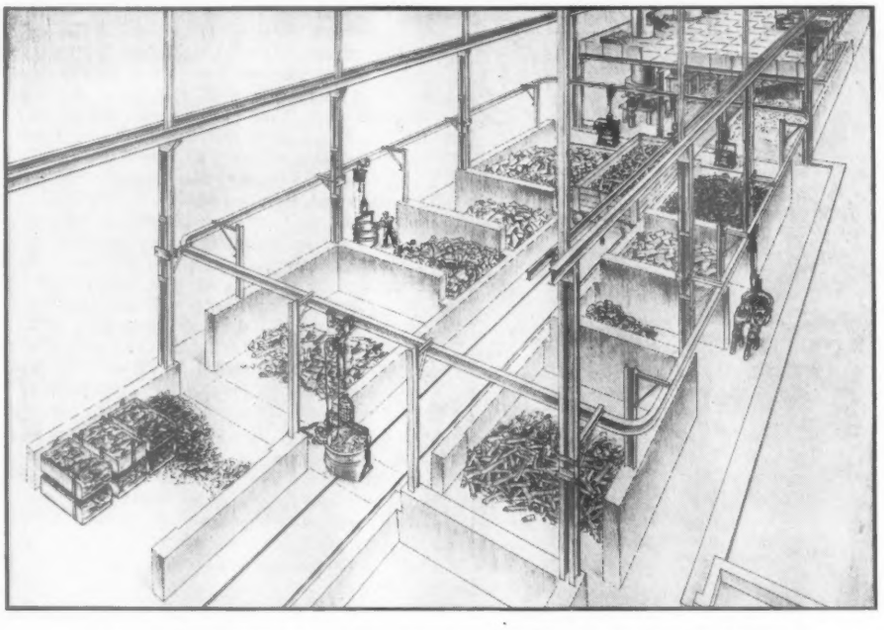


Fig. 6.—The Storage and Handling of Raw Materials for the Cupola.

Table I shows typical slag analyses, together with the calculated average total oxidation loss. This is found to be rather less than 1 per cent. of the weight of metal charged.

Air Supply

Fig. 4, which is a view from a vantage point under one end of the charging platform, effectively illustrates the layout of the air supply system. The two high-pressure fans serving the four larger cupolas are underslung from the main platform members in a position midway between the two furnace units. The blast mains are swept into the respective windbelts with only slight change of level, and in a manner calculated to offer a low degree of resistance to the air stream. Normally, No. 1 fan serves the first, and No. 2 fan the second, unit of cupolas, but the valves are positioned so as to make possible the serving of any cupola from either fan. Moreover, and this is further evidence of the flexibility of this melting plant, it is quite possible to supply any two cupolas from either single fan. This feature would be a convenience in the event of a breakdown of either fan—a circumstance which has not yet been experienced.

Twin "Kent-Hodgson" manometers, installed adjacent to the fans, indicate the respective volumes of free air passing in unit time to each of the cupolas in service. The entire absence of uprising mains represents a very real contribution to the neatness of the plant, and renders the cupola bottoms easily accessible.

Table I.—*Typical Slag Analyses, with Calculated Melting Losses.*

	October	November	December	Average
Silica ($Si\ O_2$)	47·46	48·50	46·76	47·57
Alumina ($Al_2\ O_3$)	6·51	9·72	10·30	9·51
Iron Oxide ($Fe\ O$)	10·14	10·39	10·69	10·41
Manganese Oxide ($Mn\ O$)	2·74	5·58	5·67	4·66
Lime ($Ca\ O$)	26·10	23·22	23·50	24·27
Magnesia ($Mg\ O$)	5·58	2·74	3·09	3·80

Average Silicon loss from metals charged = approx. 10% of that available
Average Silicon content of metals charged = 2·5%
Weight of metals charged : Weight of slag produced is as 22 : 1
∴ Concentration in the slag of Silicon oxidised from the metals charged :- $\frac{2.5 \times 10 \times 22}{100}$ % = 5·5%
Iron concentration in the Slag :- $\frac{10.41 \times 56}{72}$ % = 8·1%
Manganese concentration in the Slag :- $\frac{4.66 \times 55}{71}$ % = 3·6%
Total concentration in the slag of elements oxidised from the charged metals :- 17·2%
But the metal weight : Slag weight ratio is 22 : 1
Therefore oxidation loss from metals charged = $\frac{17.2}{22}$ = 0·8%

Charging

Systems providing for the charging of cupolas by mechanical means are very frequently regarded as being, at best, only somewhat inferior substitutes for hand-charging. When such comparisons are attempted, a great deal depends upon the particular types of mechanical and of manual charging contrasted, and general verdicts are, therefore, quite impossible. Experience at Renfrew, however, definitely has shown that, since the installation and operation of the system of mechanical charging about to be described, the cupolas have attained to, and have maintained with absolute consistency, a standard of performance which had never before been possible. The management is proud of the charging system, principally because it was conceived and constructed within the organisation.

The two essential requirements of the design were:—

(1) The provision of means to ensure accurate weighing, in an easy and rapid manner, of all of the constituents of the furnace charges: these to be contained in self-discharging vessels of robust construction, simply operated, and (2) the provision of means whereby the charges, thus prepared and contained, could readily be transported to, and deposited within, the cupolas.

The weighing apparatus is shown in detail in Fig. 5. The self-discharging vessels in use are suspended, by means of roller-block, chain-hoist

(*Continued on page* 240.)

Alloy Cast Iron

By H. A. MacCOLL, B.Sc.

(*Continued from page* 220.)

Molybdenum

The use of molybdenum has increased extraordinarily during the past few years, particularly in the U.S.A. When added to cast iron, molybdenum passes partly into solid solution in the ferrite, and also forms complex carbides, but this latter tendency is small compared with chromium. These effects are reflected in a strong sorbitising effect on the matrix. Additionally, there is a decided refining action on the graphite, accompanied by superior distribution.

The effects on the mechanical properties are shown in Fig. 5, which shows the influence of

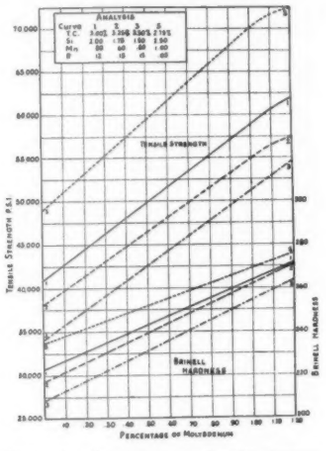


Fig. 5.—Effect of Molybdenum on Tensile Strength and Hardness.

increasing molybdenum content on four base irons. It will be noted that the additions are more effective when added to a low-carbon base. It should also be noted that the hardness does not rise proportionally with the increase in strength and thus introduce machining difficulties.

One of the most striking effects brought about by additions of this element is the remarkable "mass effect." Steelmakers are well aware of this propensity, and it has proved no less successful in the case of cast iron. Fig. 6 shows the Brinell hardness taken across the feeder head of a hydraulic ram, and the extraordinary uniformity will be noted. The analysis of the iron was T.C, 2.96; Si, 1.46; S, 0.102; P, 0.128; Ni, 0.61; Cr, 0.23, and Mo, 0.58 per cent., and whilst the nickel-chromium addition may have been a contributory factor, the major influence must be credited to the molybdenum.

The transverse strength is also improved by molybdenum additions for the same reasons as the improvement in tensile strength and hardness; the deflection is also raised. Experiments show that the transverse strength of an ordinary grey iron (T.C, 3.31; Si, 2.27, and Mn, 0.65 per cent.) may be raised by as much as 9 cwts. by addition of 0.5 per cent. Mo, the deflection increasing from about 0.225 to 0.325 in.

From the point of application in the foundry, molybdenum additions offer important advantages. The element may be added satisfactorily in the ladle, and since the amount to be added is small, the metal is not cooled to any appreciable extent. A wide variation in properties can be obtained, according to the extent of the addition, which means that one base iron may be used to satisfy several requirements. Finally, molybdenum reduces "patternmaker's shrinkage," which minimises contraction stresses and the consequent risk of cracking and tearing.

Molybdenum finds its greatest use in combination with other alloying elements. Popular combinations are Cr-Mo, Mn-Mo, Ni-Mo, and Cu-Mo. Combination with nickel appears to produce the maximum beneficial effects on the physical properties. This effect combines high tensile strength, transverse strength and deflection, with intermediate hardness and outstanding machinability.

Although virtually unknown in 1929 except for use in chilled rolls, its use, so far as the U.S.A. is concerned, is practically universal for castings of high strength requirements. Strengths of twenty tons are easily obtainable with hardnesses of under 300 Brinell. Applications include motor-vehicle and diesel castings, dies, pressure and machine-tool castings, and gears. Some typical analyses are set out in Table X.

It may be thought that the information given suggests that molybdenum is the founder's "philosopher's stone," but the author finds that British information concerning this element is comparatively scarce compared with that available in the case of nickel and chromium, and this opportunity has been taken to emphasise the potentialities of molybdenum. British Papers available include work by Smalley,[29] West,[30] Hurst,[31] and others.

Table X.—*Typical Analyses and Applications of Molybdenum Cast Irons.*

Application.	T.C.	Si.	Mn.	Ni.	Cr.	Mo.	Cu.	V.
High-strength iron	2.8	2.2	0.8	—	—	0.35	—	—
Hot working dies	3.3	1.3	0.5	—	—	0.9	—	—
Heavy lathe beds	3.1	1.25	0.75	1.0	—	0.5	—	—
Valve bodies	3.21	2.16	0.81	—	0.31	0.41	—	—
High-pressure pumps	3.16	1.36	0.55	1.03	0.41	0.73	—	—
Diesel pistons	2.55	1.6	0.7	1.25	—	0.7	—	0.12
Cylinder blocks	3.1	2.0	0.8	—	0.5	0.3	0.6	—

Vanadium

The effects of vanadium have been studied over a prolonged period. The earliest reference the author can trace is a Paper by Smith[32] in 1909, since which time some thirty or more other Papers have appeared. British workers include Norris,[33] Hatfield,[34] Donaldson,[35] Campion,[36] Hurst[37] and Norbury.[38] Germany is represented by Piwowarsky,[39] Bardenheuer and Zeyen,[40] Pfannenschmidt[26] and others, whilst a notable worker in this field has been Challansonnet[40 41 42] in France. It is, however, in the U.S.A. that vanadium irons have been in regular production for many years, and numerous Papers have appeared in the technical Press of that country.

Vanadium is the most powerful of the carbide-forming agents. The effects on the matrix parallel those of chromium; at the same time, there is a marked tendency to improve the graphite as regards both flake size and distribution. Vanadium also exerts a well-recognised deoxidising effect, accompanied by degasification, which is reflected in better transverse strength.[26]

The general effects on the mechanical properties are as follow:—Hardness is increased; as little as 0.1 per cent., when added to an iron with a total carbon of 3.1 per cent. and a silicon content of 1.8 per cent., will raise the hardness 15 to 20 points. The larger differences occur in the thicker sections, thus giving the much sought equalisation. The change in tensile strength, when added to plain irons, is roughly proportional to the increase in hardness, but when added in conjunction with other elements the tensile strength rises more rapidly than the hardness. As an example, a strength increase of 10 tons per sq. in. can be obtained with an increase of 75 points Brinell, using a 2 per cent. copper-vanadium iron, whilst a corresponding increase in a plain iron will involve a difference of about 170 points Brinell. The advantages from the machining aspect will be obvious.

Table XI.—*Typical Analyses of Alloy Cast Irons containing Vanadium.* (*Amer. Van. Corp.*)

Application.	T.C.	Si.	Mn.	Ni.	Cr.	Mo.	Cu.	V.
Brass mill rolls	3.0	0.8	0.3	—	—	—	—	0.25
Grate bars	3.7	1.7	0.55	—	—	—	—	0.15
Brakedrums	3.15	1.9	0.65	—	—	—	1.5	0.1
Forming dies	3.6	1.4	0.5	2.0	0.7	—	—	0.15
Diesel heads	3.05	1.85	0.8	1.25	—	0.75	—	0.1

Alloys containing vanadium in conjunction with nickel, copper, chromium and titanium are utilised for a wide variety of purposes, particularly in the U.S.A. In all cases the vanadium addition is of a very small order. Table XI shows a few typical examples from American practice illustrating the many alloy combinations.

Copper

Copper additions to cast iron have received their full share of attention. The first work appears to have been undertaken about 1900, after which, except for an odd Paper or two, little interest appears to have been taken until after the war. From 1920 onward there have been frequent Papers, more particularly from German and American sources. The latest British publications are those of Sallitt[43] and Nicol Smith,[44] and a monograph published by the Copper Development Association.[45]

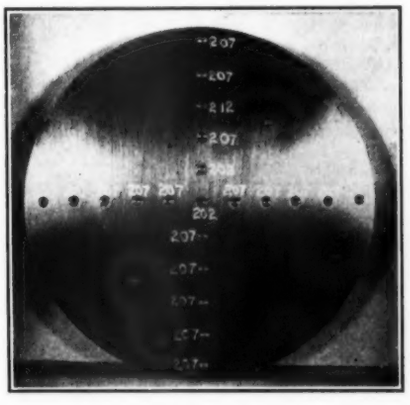


Fig. 6.—Section of a 6½ in. Round Bar showing Uniform Hardness.

The influence of copper on chill has aroused controversy, but there is a preponderance of opinion in favour of regarding copper as a graphitising agent. The work of Nicol Smith

indicates that copper only acts as a graphitiser up to additions of 3 per cent., after which it tends to induce chill, this being attributed to a dilution effect, and not to carbide formation. The effect on the microstructure is slight, graphite and pearlite refinement being reported. Super-cooled graphite is induced under certain conditions.

The mechanical properties, tensile and transverse strengths, and hardness are raised to a slight degree by simple copper addition, but the effects are noticeable if the copper addition is coincident with silicon reduction, as in the case of nickel. Carbon content also exerts a marked effect under these conditions, and maximum benefits apparently necessitate carbon contents of under 3 per cent. Opinion appears divided on the question of the relative merits of a copper addition as compared with other elements, but it has been suggested that copper may find useful application, by employing it to replace nickel in part, in which case the economic benefits are unquestionable. Copper does, however, form a valuable constituent of certain complex alloy irons, such as the chromium-copper iron developed for the "Ford" cast crankshaft, the austenitic iron Ni-resist, copper-chrome-molybdenum cylinder irons, etc.

Other Elements

Many other elements have been added to cast iron from time to time, but their use, as yet, cannot be considered as beyond the early development stage. Attention may be directed to two of these elements, namely, aluminium and titanium. The former functions as a graphitising agent when added in small quantities, and also acts as a deoxidising agent. With larger quantities the iron becomes white, and heat- and corrosion-resisting properties have been reported by a number of workers. Founding difficulties are encountered, due to scum formation. Titanium has a very strong graphitising action, superior to that of silicon when the amounts are small. Improved transverse strength and wear resistance are claimed.

Heat-Treatable Cast Irons

The foregoing remarks have been applied specifically to alloy irons in which alloy additions have been used to secure improved structure and mechanical properties in the as-cast condition. However, since the matrix of a cast iron is, in effect, identical with that of a fairly high-carbon steel, possibilities for heat-treatment exist. It has been found that ordinary cast iron will not stand the thermal shock of a quenching treatment; but with alloy additions the critical points, and the rate of cooling necessary to induce hardening, may be altered to permit of heat-treatment without trouble due to cracking. Hardness of the order of 400 Brinell may be obtained in the as-cast condition by the use of a fairly high nickel content, with or without chromium; a typical composition is 5 per cent. nickel and 0.75 per cent. chromium. Such an iron has a martensitic structure, and is only machinable using tools of the Widia type, and finishing by grinding.

In many cases, however, hardness of the same order may be sought in the finished article, but the machining costs might be prohibitive if carried out on the hardened material, and the heat-treatable cast irons have been developed to meet these conditions. The nature of these irons is such that, in general, they are easily machinable as cast, after which they may be quenched and tempered to the required hardness. The nature of the heat-treatment will vary with the section of the casting. With increasing section, the alloy content must be raised to ensure full hardening. This may result in some degree of "air-hardening" in the lighter sections as cast, but an annealing treatment, followed by slow cooling, will soften the casting throughout, enabling the machining operation to be carried out, the material being subsequently hardened by further treatment.

The popular heat-treatable irons contain 2 to 3 per cent. of nickel, with or without chromium, the latter addition being recommended for heavy sections. The heat-treatment consists of a quench in oil from 850 deg. C. followed by tempering to the desired strength and hardness. By varying the tempering temperature between 300 and 600 deg. C., tensile strengths of from 16 to 20 tons per sq. in. are readily obtainable, with Brinell numbers of 350 to 400. For softening purposes, it is only necessary to reheat to about 600 to 700 deg. C. and furnace-cool. For detailed information Papers by Hurst[46 47] and many other workers[48 49] are available.

A special form of heat-treatment for the production of intense surface hardness is the process known as "nitriding," well known in connection with steels and applied to cast iron by Hurst[50 51 52]. The iron used contains chromium and aluminium, a typical analysis being T.C, 2.6; C.C, 1.23; Si, 2.58; Mn, 0.61; Cr, 1.69, and Al, 1.43 per cent. The process consists of subjecting the material to the action of dry ammonia gas at a temperature of approximately 500 deg. C. The castings are nitrided *after* quenching and tempering, the operation taking from 60 to 90 hrs., according to the depth of penetration required. Hardnesses of 600 to 700 Brinell may be obtained in this manner. This process is being applied with great success to the production of motor-vehicle cylinder liners; in fact, one can generalise to the extent of stating that the motor-vehicle industry offers the largest field so far for the employment of heat-treated cast irons.

Special Irons

The last few years have seen the evolution of a number of alloy irons having outstanding properties in their own particular fields. In general, these consist of irons containing appreciable percentages of alloy elements, and their manufacture may involve departures from ordinary foundry practice. Prominent amongst these irons are the heat- and corrosion-resisting irons known by such names as Silal, Nicrosilal, and Ni-resist; irons produced by the process of inoculation, with or without alloy addition, such as Meehanite and Ni-tensyl, and finally chilled alloy iron such as Ni-hard. It is outside the scope of this Paper to deal at length with these irons, but the salient features will be indicated.

Heat-Resisting Irons

Ordinary grey iron, when subjected to high temperatures, particularly if of an intermittent nature, exhibits the phenomenon of "growth." This involves a marked permanent expansion, coupled with cracking and flaking of the surface, with the result that the life of the material is short. This phenomenon has received extensive study, and it has been established that the root cause of the trouble lies in the oxidation of the graphite flakes together with decomposition of the matrix pearlite. The development of heat-resisting irons has, in consequence, been associated with the production of irons containing a minimum of graphite, coupled with as fine a flake size as possible, removal or stabilising of the pearlite, and the addition of other elements resistant to oxidation. Another factor of importance, in the case of intermittent heating, is the volume change associated with the passage of the iron through the carbon change point; hence removal of the critical point to a temperature outside the working range of the material will also assist the problem.

White irons, irons of low silicon content, and low alloy irons are all superior to ordinary grey cast iron, but each has its own particular disadvantages, and intensive research during the last few years has led to the introduction of irons of vastly superior resistance.

The British Cast Iron Research Association has introduced two irons in the heat-resistance field known as Silal and Nicrosilal. Silal[53] is a high-silicon iron with a low total carbon. The silicon percentage varies from 4 to 10 per cent., and the carbon is present almost wholly as graphite in a very fine state of division. The matrix consists of ferrite only. A moment's reflection will enable one to realise that the heat-resisting properties are due to the manner in which such a structure reduces the growth-promoting factors.

Silal has proved very satisfactory where the service conditions have been pure heat-resistance. It is very brittle, however, and should not be used under conditions of stress, whilst rapid heating and cooling may also cause trouble due to cracking. The silicon content is adjusted to the temperature requirements, and it is important that it should be chosen with care, as too high a value will mean unnecessary brittleness and machining difficulty, whilst too low a value will mean inferior heat-resistance, in which connection Morgan has pointed out that internal oxidation in an iron of this class may result in more rapid failure than a common iron. A typical analysis of a Silal iron suitable for work at, say, 900 deg. C. is:—T.C, 2.39; C.C, 0.08; Si, 5.72; and Mn, 0.68 per cent.

(To be continued.)

BIBLIOGRAPHY.

29 O. Smalley, Foundry Trade Journal, 1927, p. 3.
30 "Recent Developments in Cast Iron," W. West, "Metallurgia," 1934–35, vol. 11, pp. 54–56.
31 "Study of the Influence of Manganese and Molybdenum Additions to Cast Iron," J. E. Hurst, Proc. I.B.F., 1935–36, vol. 29, p. 202.
32 "Use of Vanadium in Cast Iron," J. K. Smith, "Foundry," 1919, vol. 33 (6), p. 268.
33 "Influence of Vanadium on Cast Iron," G. L. Norris, Foundry Trade Journal, 1910, vol. 12, p. 402.
34 "Influence of Vanadium on Physical Properties of Cast Iron," W. H. Hatfield, J.I.S.I., 1911, p. 318.
35 "Influence of Vanadium in Cast Iron," J. Donaldson Foundry Trade Journal, 1918, vol. 20, p. 207.
36 A. Campion, Foundry Trade Journal, 1918, p. 467.
37 "Influence of Vanadium and Cobalt Additions to Cast Iron," J. E. Hurst, "Iron & Steel Industry," 1933, vol. 7, pp. 67–70.
38 "Factors Influencing the Hardness of Cast Iron," A. L. Norbury, *Metallborse*, 1930, vol. 20, p. 1939.
39 P. Bardenheuer and K. L. Zeyen, *Die Giesserei*, 1928, p. 969.
40 "Dilatometric Analysis of Some Synthetic Cast Irons containing Vanadium and Nickel-Vanadium," J. Challansonnet, *Comptes Rendus*, 1930, vol. 190, p. 939.
41 "Study of Nickel-Vanadium and Nickel-Molybdenum Cast Iron," J. Challansonnet, *Revue de Metallurgie*, 1930, vol. 27, pp. 575 and 674.
42 "Natural Titanium-Vanadium Cast Irons," J. Challansonnet, Bull. A.T.F., 1932, vol. 6, p. 542.
43 "Copper in Cast Iron and Malleable Iron," W. B. Sallitt, Foundry Trade Journal, 1937, vol. 57, pp. 354–57 and 379–80.
44 "Copper in Cast Iron," J. Nicol Smith, Proc. I.B.F., Paper No. 638.
45 "Copper in Cast Steel and Iron," Copper Development Association.
46 "Oil-hardening and Air-hardening Cast Iron," J. E. Hurst, Proc. I.B.F., 1930–31, vol. 24, p. 373.
47 "Further Experiments on Oil-hardening and Air-hardening Cast Iron," J. E. Hurst, Foundry Trade Journal, 1931, vol. 45, pp. 345–348.
48 "Some Recent Developments in Automobile Cast Iron," T. R. Twigger, Proc. I.B.F., 1931–32, vol. 25, p. 382.
49 "Heat-treatment of Cast Iron," A. A. Timmins, Foundry Trade Journal, 1936, May 28, p. 421.
50 "Hardening Cast Iron, Hardened and Tempered Cast Iron, Nitrogen-hardened Cast Iron," J. E. Hurst, Proc. I.B.F., 1931–32, vol. 25, p. 146.
51 "Some Experiments on the Nitrogen-hardening of Cast Iron," J. E. Hurst, J.I.S.I., 1932, No. 1, p. 223.
52 "Cast Iron Suitable for Nitrogen-hardening," J. E. Hurst, A.F.A., 1937, preprint No. 37–22.
53 "Effect of Carbon and Silicon on the Growth and Scaling of Cast Iron," A. L. Norbury and E. Morgan, J.I.S.I., 1931, No. 1, p. 413.

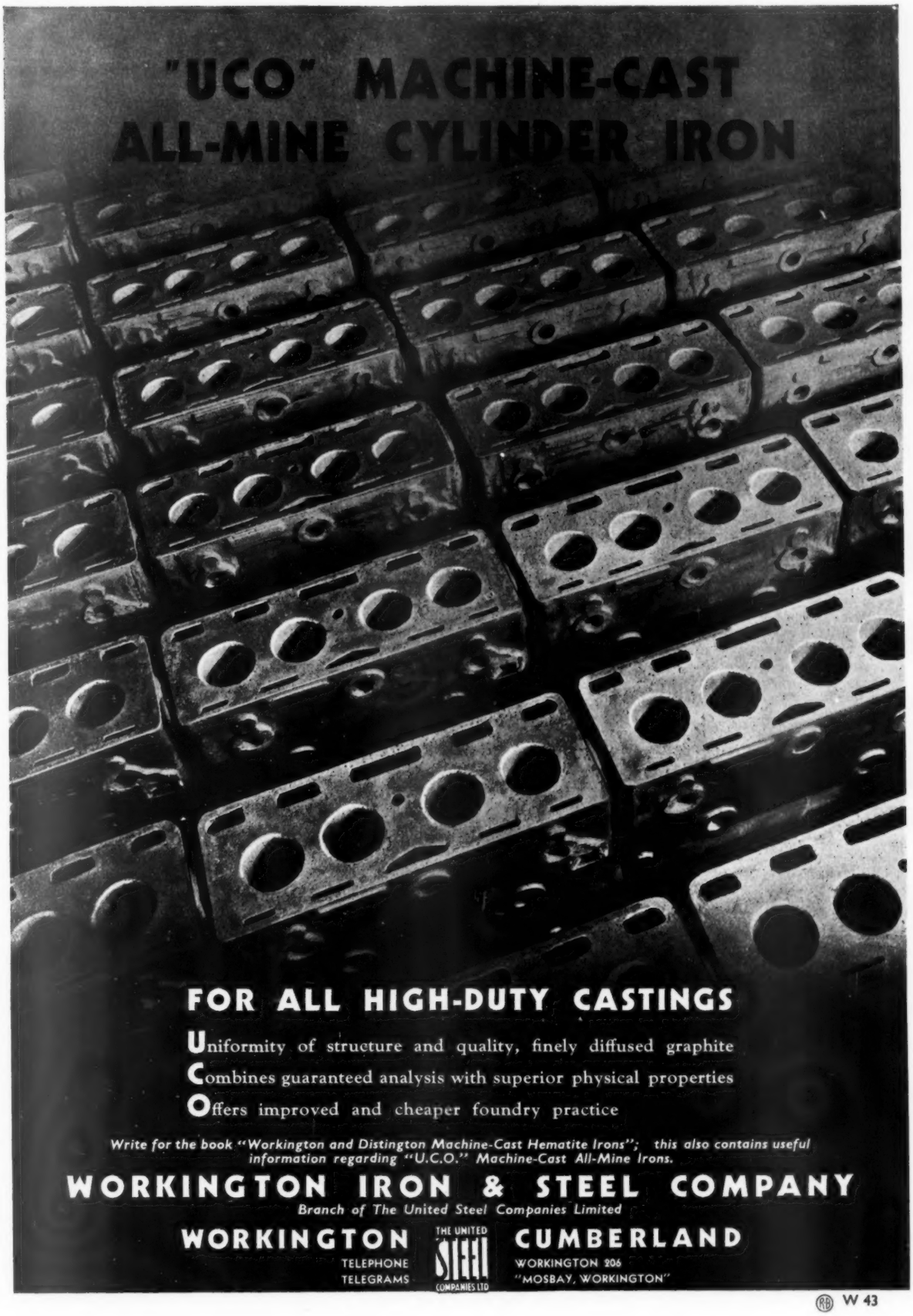
Iron and Steel Output

There were 88 furnaces in blast at the end of February, compared with 83 at the end of January, seven furnaces having resumed operations during the month and two having ceased operations.

The production of pig-iron in February included 101,600 tons of hematite, 311,000 of basic, 87,400 of foundry, and 10,700 of forge pig-iron.

The output of steel ingots and castings in Great Britain during February was 971,200 tons, representing a rise of 27 per cent. in the daily output compared with January. The output was the highest since March, 1938.

A. Reyrolle & Company, Limited, electrical engineers, of Hebburn, have completed, at a cost of over £20,000, a scheme of underground shelters and other protective measures for 5,500 workpeople.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The "White Deposit" Defect in Large Iron Castings*

By A. Le THOMAS

The defect to be dealt with relates to relatively large masses of ordinary cast iron. It was described by a correspondent of the Centre de Recherches de Fonderie, and was printed in their Bulletin.† On stripping, the casting appeared to be normal, the casting being true to shape. With the first blow of the fettling hammer, however, a white crust several millimetres thick detached itself. This was sufficient to make the casting unsightly and cause its rejection. The white crust is more usually found at re-entrant angles of large castings, such as the roots of teeth in large gear wheels, and close to the runners. It is rare for the defect to be systematic, that is to say, that it shows itself up in a foundry during a relatively long period of time, affecting an important proportion of castings. Actually it is in general a localised defect unconnected either with time or process, which is something to be thankful for. This circumstance nevertheless hinders investigation, and no anterior systematic researches can be turned to for enlightenment. Fig. 1 shows by way of a characteristic example a large flywheel exhibiting the defect in question. The defects outlined above are well shown up. The white deposit yielded the following composition:—SiO_2, 72.20; Al_2O_3, 2.56; CaO, trace; MgO, trace; Fe_2O_3, 6.52; MnO, 6.72; S, 1.37; and C, 10.55 per cent. The various analyses which have been made under similar circumstances differ very little from the one detailed. It discloses a mixture of graphitic particles, apparently arising from the separation of the graphite flakes of the iron with the product of the scorification of the sand of the mould by contact with more or less oxidised slag, also freed from the iron.

Characteristic Conditions

When the iron constituting the castings affected by the defect is examined, the following observations are called for:—(1) The iron is, generally speaking, high in silicon, at least when related to the mass of the casting. That is to say, silicon contents up to 2.12 per cent. have been found in large castings showing up the "white" defect, when a reasonable amount would be of the order of 1.20 to 1.40 per cent. for the section thicknesses disclosed.

(2) The manganese is generally low—something of the order of 0.3 to 0.4 per cent.—which again is abnormal. At the same time, the sulphur is relatively high—nearly always higher than 0.10 per cent.

(3) The skin of the casting on a thickness of 1 to 3 mm. in contact with the "white" shows up under the microscope all the characteristics of an annealed and oxidised iron. Actually the "white" seems to be due to a release of heat capable of modifying the surface structure of the casting.

A circumstance of a practical character which explains the usual high silicon, inadequate manganese and excessive sulphur in the defective casting is worth citing. It will be best set out in the terms of a letter received from a foundryman who frequently found the defect in the bores of very large bosses (Fig. 2).

"The castings affected by 'white' weighed 18 to 30 cwts. They were ordered as an ordinary cast iron and the cupola charge consisted of equal parts of No. 3 pig and scrap. The customer was not interested in high quality, which would have influenced cost. These castings were machined all over and there were no defects except in the place indicated."

How the Defect Arises

It is frequently true that for casting very large castings about which the only demand is the presentation of a decent appearance, the founder is tempted to make up the cupola charge as

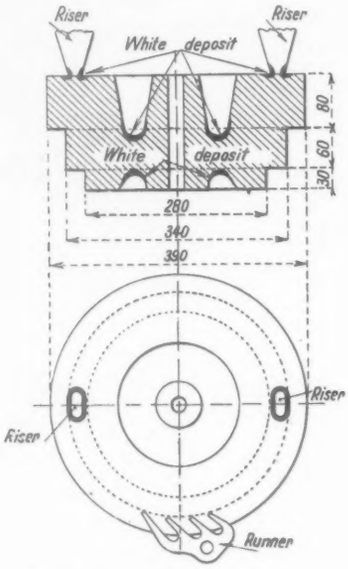

FIG. 1.—SHOWING TYPICAL LOCATIONS OF THE WHITE DEPOSIT IN A LARGE FLY-WHEEL CASTING.

indicated above, associated with the use of a minimum of melting coke. The high proportion of scrap introduces into the melt abnormal conditions inducing high sulphur and low manganese. Parenthetically it should be stated that these factors bring about difficulties in machining.* Moreover the scrap used frequently in-

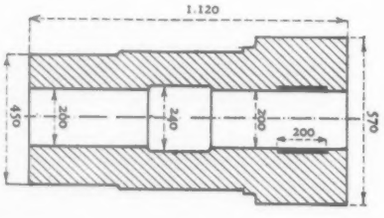

FIG. 2. SHOWS THE POSITION OF THE WHITE DEFECT IN THE INTERIOR OF A BOSS.

cludes a large proportion of relatively highly siliceous small pieces, whilst the use that is made of ordinary foundry pig to complete the charge also increases the silicon content. Finally the phosphorus content of the mix is high. Actually what happens is as follows:—

Whilst the iron which is filling the mould is still liquid—and it remains liquid for a pretty long time due to the mass of the casting and the high silicon and phosphorus content—a certain amount of decantation takes place. The graphite flakes, slag—more or less oxidised—and manganese sulphide pass through the liquid mass and plaster the walls and floor of the mould. Then there takes place a scorification due to a reaction between the moulding sand and diverse materials, some of which are capable of being oxidised (graphite and manganese sulphide), others liable to give up oxygen (various oxidising slags). These aid the action of the atmospheric air, which penetrates through the pores of the mould. It is understood that the scorification, a true chemical reaction brought about by heat, will be increasingly active with the prolongation of the period of high temperature, which determines the localisation of the defect as has been previously stated.

The Remedy

The remedy is easy. It suffices to use iron of an appropriate chemical composition as related to the large mass of the casting to be made: that is to say relatively low sulphur and phosphorus content and adequate manganese. As an indication, but without giving figures of universal applicability (because other considerations such as high mechanical properties, wear resistance, etc., can also influence the make-up of the charge) the following chemical composition is recommended:—T.C, 3.0 to 3.4; Si, 1.2 to 1.4; Mn, 0.7 to 0.9; S, less than 0.10, and P, 0.10 to 0.30 per cent. This is easily obtained from the cupola by using the following percentage mix:—

Scrap (runners and risers from similar irons)	25
Heavy machinery scrap	25
Ordinary hematite (2.5 per cent. Si; 1 per cent. Mn)	30
Small mild steel scrap	20

A directly utilitarian point of view would embrace a remedy often applied in various foundries, which, when "white" appears at the re-entrant parts of large castings, consists of adding small quantities of ferro-manganese to the charge—often in briquette form. This cure, without being complete, is usually sufficient to eliminate the defect for a time.

The practical interest of the above observations is assured because of the numerous observations made since the existence of the Centre de Recherches de Fonderie. The works which have received the advice given above have since been free from the defect. One foundry wishing to test the advice, actually returned to previous practice and the white deposits reappeared.

This short Paper would be incomplete if no reference were made to some very interesting work by Ivan Lamoureux which he detailed in "White Deposits on Iron Castings"* in 1914. The author had no knowledge of this work when in 1933 he published in "La Fonte" a Paper on the same subject. The practical conclusions of Mr. Lamoureux's work were pretty much the same as the author was able to put forward on the basis of his own tests. It is now a sincere pleasure to render homage to this Belgian foundryman, who did so much to elucidate problems before the present means of investigation were available.

Nickel Estimations in Presence of Iron

To facilitate the quantitative estimation of traces of nickel in the presence of iron, E. REICHEL and L. STUZIN, in "Zeit. f. Analytische Chemie," give a method for determining between 3×10^{-5} to 10^{-4} grm. of Ni in the presence of 1,000 to 1,500 times that quantity of Fe. The estimation is based on the precipitation as ferricyanide of nickel, with zinc added as a nucleus, in a dilute HCl solution containing ammonium fluoride, the Ni being extracted from the precipitate with solid dimethylglyoxime. The metal is determined colorimetrically as sulphide with an overall error of 1 per cent.

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* Translated from the Bulletin of the Association Technique de Fonderie.

† "Un défaut de Fonderie: le blanc des grosses pieces de Fonte." "La Fonte." January, 1933.

* A. Le Thomas. "Les anomalies de trempe et leur rapport avec régularité des fabrications." Bull. A.T.F., June, 1934.

* "Bull. Ass. Tech. de Fond. de Liège." April, 1914. "Revue de Fonderie." July, 1919.

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The Week's News in Brief

Trade Talk

DARWINS, LIMITED, of Sheffield, have removed their London office to 28, Victoria Street, S.W.1.

THE SINGER MANUFACTURING COMPANY, LIMITED, of Clydebank, have taken efficient steps in training their employees in A.R.P. Tests made over a month show that the 4,000 men and women can transfer to basements and shelters in 1 min. 45 secs.

PALMERS (HEBBURN) COMPANY, LIMITED, of Hebburn-on-Tyne, have received a contract for the steelwork for the new steelworks to be built at Jarrow for the Jarrow Steel Company. The site is being cleared by T. W. Ward, Limited, of Sheffield.

A TEN-YEAR expansion programme has been planned by the United Kingdom Gas Corporation for its subsidiary undertakings in a 650 square mile area in West Yorkshire. It is based on a survey which embraced 200 different industries and trades in the area, where a vast underground gas grid system is now being established.

THE CENTENARY of Frederick Braby & Company, Limited, whose chief works are situated at Glasgow, was commemorated on March 11, when the firm entertained 1,700 employees to dinner in the St. Andrew's Hall, Glasgow. Mr. K. D. MacKenzie, manager of the Glasgow works, who presided, said that the firm now had almost 4,000 employees.

PARAMOUNT STEELS, LIMITED, of 110, Cannon Street, London, E.C.4, is being voluntarily wound up with the sole object of forming a new company to carry on the business. The new company will be called Paramount Steel Corporation, Limited. In the meantime the business is being carried on by Mr. H. W. Harding, trading as Paramount Steels.

A PROVISIONAL AGREEMENT has been reached between the directors of William Baird & Company, Limited, and the directors of the Scottish Iron & Steel Company, Limited, for the formation of a new company to take over the blast-furnace, coke-oven and colliery interests of Bairds in Lanarkshire, Stirlingshire, Dumbartonshire and West Lothian, and the whole undertaking of the Scottish Iron & Steel Company.

KAYE & COMPANY (HUDDERSFIELD), LIMITED, Moorbottom Ironworks, Huddersfield, are to commence the manufacture of non-ferrous castings in addition to their activities as ironfounders. The new department will be located at the Hope Foundry, and will be under the care of Mr. A. W. Walker, late foundry manager to T. Broadbent & Sons, Limited, of Huddersfield. Mr. Walker will join the board of directors, and will also control the iron foundry, which at present is being operated jointly with the Moorbottom Works.

Melting Practice in a Large Engineering Iron Foundry

(*Continued from page* 234.)

and dial-registering scale, from a monorail which surrounds the material bins. The respective tares of every bucket, and of every lifting bar, have been standardised, and each scale is adjusted to read as zero the total weight of any bucket on any bar. Thereafter, each scale, by units of 7 lbs., registers loads up to 21 cwts.; a non-recording interval of 3 cwts. being provided initially.

The general layout at ground level is as illustrated in Fig. 6. Storage bins for the accommodation of furnace materials are built on both sides of the permanent way which serves the bay and passes under the cupola platform. The bay is spanned by an overhead crane of 2 tons capacity, fitted to use an electro-magnet as required, and gross handling is carried out in the following manner.

The purchased materials are shunted in each evening, and discharged into their respective bins overnight, the metals by electro-magnet, and the non-magnetic materials by hand. This operation, involving the handling of up to 150 tons of material per night requires the use of the crane for approximately half of its available working time and the services of one labourer, who discharges coke, limestone, refractory materials, etc. Home scrap is delivered to its particular bin, partly during the night and regularly throughout the day, by internal transport. During the day, the crane is in use for handling the buckets to and from the cupola platform, in the manner to be described.

(*To be continued.*)

REFERENCES.

1 "The Function of Tuyeres in Cupola Control." H. V. Crawford, FOUNDRY TRADE JOURNAL, August 19, 1937.
2 "Some Experiences with the Balanced-Blast Cupola." H. H. Shepherd, FOUNDRY TRADE JOURNAL, December 29, 1932; January 12, 1933.
3 "The Balanced-Blast Cupola." W. Y. Buchanan, FOUNDRY TRADE JOURNAL, January 16, 1936.
4 "Correspondence," FOUNDRY TRADE JOURNAL, September 30, 1937.

Personal

LORD HAILEY has been elected a director of Vickers, Limited.

MR. F. H. JAMES has joined the board of the English Electric Company, Limited.

LORD MCGOWAN, of Imperial Chemical Industries, Limited, is to receive the honorary freedom of the Borough of Swansea.

Wills

GREENHALGH, ROBERT, head of Greenhalgh & Company, Limited, engineers, of Oldham £37,528

CRIGHTON, SPENCER, director of James Hodgkinson (Salford), Limited engineers £7,756

REED, HENRY, of Sheffield, chairman of Sanderson Bros. & Newbould, Limited, steelmakers £30,866

COWEN, J. E., chairman and managing director of Smith, Patterson & Company, Limited, ironfounders, Blaydon-on-Tyne £76,988

Obituary

MR. ALEXANDER DOUGAL, who died at his home in Bathgate at the age of 70, retired from the service of the Bathgate Foundry Company, Limited, a year ago.

MR. RICHARD LEIGH, for many years head of the firm of Leigh & Sons, Orlando Ironworks, Bolton, Lancs, has died, aged 92. He moved from Bolton to St. Annes-on-Sea. He was a Justice of the Peace for the county of Lancaster.

MR. BENJAMIN PEAT, secretary of Ashmore, Benson, Pease & Company, Limited, engineers, of Stockton-on-Tees, died suddenly on March 7. A native of Workington, he had been 30 years in the service of the company, and was appointed secretary in 1921. He was 50 years of age.

Contracts Open

Horsham, March 21.—3-in. spun cast-iron pipes and specials, spigoted and socketed, Class "C," coated inside and out with Dr. Angus Smith's solution, for the Urban District Council. Mr. A. Slyfield, clerk, Council Offices, Horsham Park, Horsham.

Horsham, March 21.—Spun-iron pipes and specials, ferrules and stopcocks, iron-foundry work, etc., for the six months ending September 30, for the Rural District Council Water Department. Mr. F. Fraser Haddock, clerk, Council Offices, Comewell House, North Street, Horsham.

Manchester, March 20.—1,350 yds. of 24-in. and, alternatively, 30-in. socket and spigot water pipes (equal to B.S.S. Class B schedule for cast-iron pipes) and special castings, for the Waterworks Committee. The Committee Secretary, Waterworks Offices, Town Hall, Manchester, 2.

Workington, March 21.—Spun-iron pipes and cast-iron specials; wrought-iron tubes and fittings; brass gas fittings, etc., during 12 months, for the Gas Department. The Gas Engineer, Gasworks, Workington.

Company Reports

Wellworthy Piston Rings, Limited.—Interim dividend of 5 per cent.

Broom & Wade, Limited.—Interim dividend on the ordinary shares of 7½ per cent.

Colvilles, Limited.—Final ordinary dividend of 5 per cent., making 8 per cent. for 1938.

Baldwins, Limited.—Dividend of 10 per cent. on the ordinary stock for the year to December 31 last.

Triplex Foundry, Limited.—Final dividend of 2½ per cent. on the 5½ per cent. cumulative preference shares.

J. & E. Hall, Limited.—Dividend on the 6 per cent. preference shares for the six months ending March 31.

Radiation, Limited.—Net profit for 1938, £277,831; final dividend on the ordinary stock of £9 7s. 6d. per cent., making 12½ per cent.

Vickers, Limited.—Net profit for 1938, £1,398,853; final dividend on the ordinary stock of 6 per cent., making 10 per cent. for the year.

Leeds Fireclay Company, Limited.—Interim dividend of 2 per cent. on the 6 per cent. non-cumulative participating preference shares.

Hadfields, Limited.—Net profit for 1938, £278,405; final dividend on the ordinary shares of 15 per cent., making 22½ per cent. for the year.

Watford Electric & Manufacturing Company, Limited.—Final dividend of 10 per cent., making 15 per cent. on the ordinary shares for the year.

Craven Bros. (Manchester), Limited.—Net profit for 1938, after providing for N.D.C., income-tax and depreciation, £100,653; final dividend of 15 per cent., making 22½ per cent. for the year.

James Booth & Company (1915), Limited.—Profit for 1938, £145,411; brought in, £35,017; dividend of 15 per cent. on the ordinary shares; to reserve, £50,000; to staff fund, £5,000; carried forward, £62,933.

W. Canning & Company, Limited.—Final dividend on the ordinary shares of 5 per cent. actual and a cash bonus of 2s. per share, making a total dividend of 20 per cent. for the year ended December 31, 1938; net profit for the year, £63,570.

British Thomson-Houston Company, Limited.—Profit for 1938, after setting aside £300,000 for income-tax and N.D.C., £670,644; brought in, £206,408; depreciation, £226,941; to general reserve, £200,000; 7 per cent. dividend on the ordinary shares; carried forward, £182,829.

Lancashire Steel Corporation, Limited.—Earnings for 1938 from operations of the Corporation and its wholly-owned subsidiaries, £855,560; brought in, £78,071; depreciation, £175,000; income tax and N.D.C., £273,518; staff superannuation, £25,000; stock reserve, £20,000; general reserve, £100,000; dividends on the 5 per cent. cumulative redeemable first preference shares, £50,457; dividend on the 5½ per cent. non-cumulative redeemable second preference shares, £31,838; dividend on the "A" and "B" ordinary shares of 7 per cent. for the year, £175,709; carried forward, £82,109.

Forthcoming Events

MARCH 21.

Institute of Metals (Swansea Section):—"Developments in Apparatus for Metallurgical Research," Paper by Dr. J. L. Haughton, at Y.M.C.A., Swansea, at 6.30 p.m.

MARCH 24.

Keighley Association of Engineers:—Annual dinner, at Victoria Hotel, Keighley, at 6.45 p.m.

Manchester Association of Engineers:—Annual general meeting; "Air Compressors," Paper by S. N. Howe, at Engineers' Club, Manchester, at 7 p.m.

Institute of British Foundrymen

MARCH 18.

Wales and Monmouth Branch (Bristol Section):—"Some Factors in the Production of Electric Steel Castings," by J. F. Gist, at the Merchant Venturers' Technical College, Bristol, at 7 p.m.

MARCH 25.

Bristol Section:—Annual general meeting, at Merchant Venturers' Technical College, Bristol, at 7 p.m.

East Midlands Branch:—Annual general meeting; Short Paper competition, at Loughborough College, at 6 p.m.

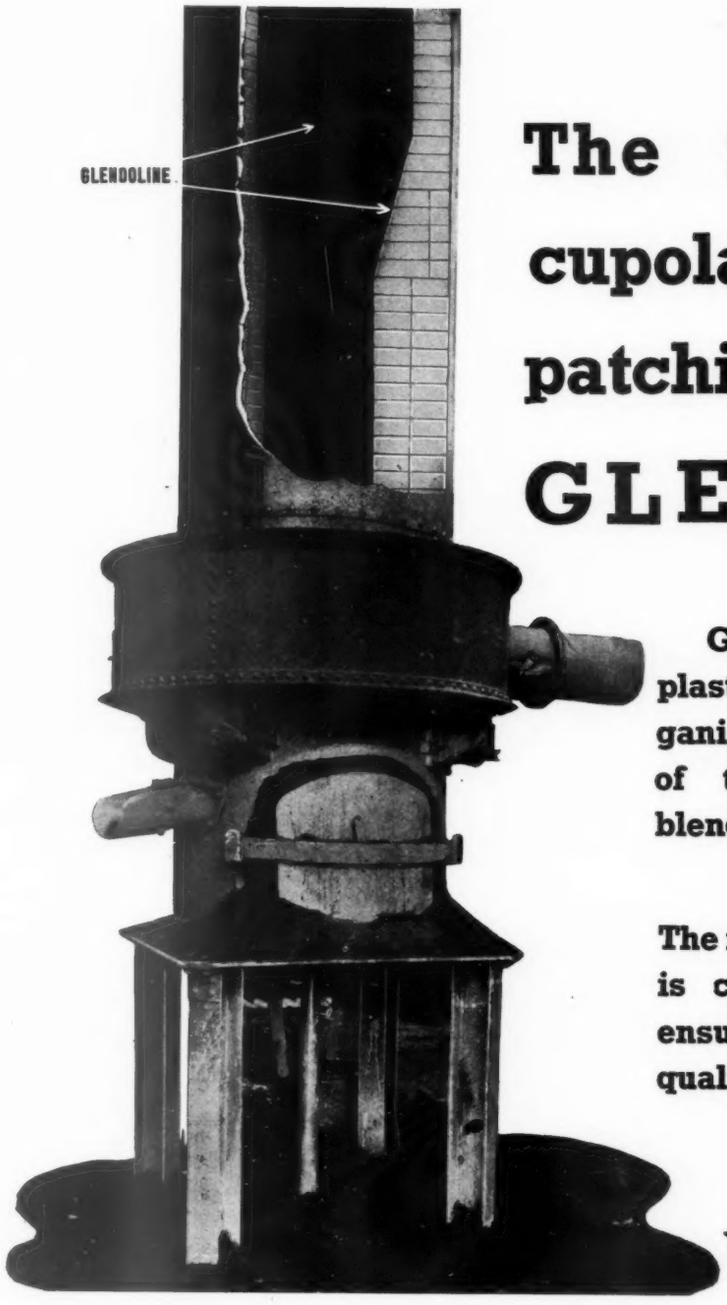
Lancashire Branch (Junior Section):—Annual social and dance, at Manchester, Limited, Café, Cross Street, Manchester, at 6.30 p.m.

Newcastle-upon-Tyne and District Branch:—Paper by T. B. Burrows; annual general meeting, at Neville Hall, Newcastle-upon-Tyne, at 6.15 p.m.

The Institute of Vitreous Enamellers

MARCH 23

Scottish Section:—"Control of Cast-Iron Enamels," Paper by A. J. D. Black, at Royal Technical College, Glasgow, at 7.30 p.m.



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Raw Material Markets

While the steel trade continues to improve steadily, business in ordinary grades of iron remains on the quiet side. Low-phosphorus iron and hematite are being used in increasing tonnages, but the demand for high-phosphorus iron shows little expansion. On the whole, the tone of the iron and steel industry is much better, largely as a result of Government defence orders.

Pig-Iron

MIDDLESBROUGH.—Business in Cleveland iron continues to be at a very low ebb, and it cannot be said that there are any prospects of an early improvement, owing to the continued slackness in the light-castings trade. Consumers are not buying forward, and any new business that transpires is restricted to small tonnages for early delivery. Some users continue to hope for lower quotations, but no indication of these has been forthcoming from the makers, who quote 99s. for No. 3 Cleveland G.M.B. foundry iron, 102s. for No. 1 foundry and 98s. for No. 4 foundry and No. 4 forge iron, all less 5s. per ton rebate, delivered in the Middlesbrough and Falkirk areas.

There has been a fair amount of new business in hematite of late and the outlook in this section of the trade continues to improve. Most consumers are well contracted, but the call for deliveries under existing commitments is on a much better scale. At the present time the demand is in excess of the production, but it is unlikely that there will be any need for higher outputs for some time, as most makers have fairly substantial stocks on hand. East Coast hematite mixed numbers are quoted at 120s. per ton on the North-East Coast, 120s. 6d. in Scotland, 125s. 6d. in Sheffield, and 131s. in the Midlands, all less 5s. per ton rebate.

LANCASHIRE.—There appears to be rather more business about among the local consuming works, but this has not yet been reflected in the demand for foundry iron. There has been a slight improvement in the number of orders at the ironworks, but business is still far from satisfactory. When contracts expire, buyers are taking supplies on a hand-to-mouth basis. For delivery in the Lancashire price zone, Derbyshire and Staffordshire brands of No. 3 foundry iron are quoted at 104s., and Northamptonshire No. 3 at 102s. 6d. Hematite is in better request, although more orders would be welcomed by makers. West Coast hematite is offered at 128s. 6d. and East Coast material 128s., both delivered to consumers in the Manchester district.

MIDLANDS.—Business in high-phosphoric pig-iron is still restricted to small tonnages for early delivery, and few consumers can be persuaded to contract ahead at the present time. Activity among the light-castings founders continues to be well below the average for the time of the year, and the outlook for this consuming trade is not at all bright. Hope is placed on the fact that the building trade is expected to improve shortly, and this should help to revive activity at local foundries. For delivery to Birmingham and Black Country stations, Derbyshire No. 3 foundry pig-iron is quoted at 101s., with Northamptonshire No. 3 at 2s. 6d. per ton less than this figure. There continues to be a substantial demand for low-phosphorus iron, which is largely used by the speciality engineers. The minimum price of this iron is £5 5s., according to quality and the position of supplies. The consumption of hematite is much better than it was a short time ago, and users are calling for deliveries at a steady rate. Not very much new business has been done as yet, but a good number of contracts are due to expire shortly, and consumers are likely to renew them over quite a long period.

SCOTLAND.—With the light-castings founders still working very intermittently, the outlook in this area is not at all satisfactory. Contracts are not generally being renewed in full, and hand-to-mouth buying is the rule. The price of No. 1 foundry iron is 108s. per ton, with No. 3 at 105s. 6d., f.o.t. furnaces. Owing to the fact that Midland iron can be obtained at 1s. 3d. per ton below the quotation for Cleveland iron, there is little of the latter being used at present. Activity at the local steelworks is rather better, but the absence of large-scale buying by the shipbuilders continues to restrict working time. Hematite mixed numbers are quoted at 120s. 6d., with basic iron at 92s. 6d., both delivered steelworks and subject to 5s. rebate.

Coke

Satisfactory business continues to be done in the foundry-coke market. The number of orders now coming to hand is perhaps rather smaller than it was a month or two ago, but makers have sufficient business in hand to keep them well employed, and they have no intention of reducing the official minimum level of 50s. 6d. per ton for Durham and Welsh coke, delivered Birmingham and Black Country stations.

Steel

The steel market continues to present quite an active appearance. One of the weakest sections is the structural department, and orders here are not particularly active. The building trade is still on the quiet side, while the shipbuilders are not placing orders for structural steel on anything like the scale that might be expected. Sheet-makers are busy and large orders from the Government in connection with A.R.P. are likely to maintain activity in this section at a good level for some time to come. Most kinds of billets are in better request, but more business would be welcomed in many instances. The fact that the output of steel in February showed a 27 per cent. increase over that of the previous month indicates the expansion in trade that has taken place during the past few weeks.

Scrap

In most areas the consumption of scrap at the steelworks continues to expand. Unfortunately, the increased business has rather caught suppliers unawares, and the demand cannot always be satisfied in full; in fact, there are numerous complaints that tonnages are not forthcoming without considerable delay. It is understood that arrangements have been made for the importation of a large tonnage of scrap in order to relieve the position in this country.

Metals

Copper.—World stocks of refined copper increased during February by 13,000 short tons to 493,000 tons, while blister stocks fell by 1,000 tons. World consumption was 1,000 tons lower at 150,000 tons. The increase in stocks occurred despite a sharp fall in both blister and refined output. A firmer tone has been noticeable in this market during the past week, and business has been slightly more active. Consumers have specified more freely against existing contracts. The renewal of Nazi demands in Czecho-Slovakia has, however, done much to destroy any improvement that had been made. It is reported from New York that the Chilean Chamber of Deputies has given final approval to a scheme for a progressive tax on the proceeds of export copper, to be based on "world prices." The plan forms part of a general programme designed to finance the reconstruction of the earthquake zone.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £43 11s. 3d. to £43 12s. 6d.; Friday, £43 6s. 3d. to £43 8s. 9d.; Monday, £43 3s. 9d. to £43 5s.; Tuesday, £43 5s. to £43 6s. 3d.; Wednesday, £43 10s. to £43 11s. 3d.

Three Months.—Thursday, £43 17s. 6d. to £43 18s. 9d.; Friday, £43 12s. 6d. to £43 15s.; Monday, £43 8s. 9d. to £43 10s.; Tuesday, £43 10s. to £43 11s. 3d.; Wednesday, £43 15s. to £43 16s. 3d.

Tin.—Owing to the more unsettled outlook in the European political situation, conditions in this market have been rather quiet of late. Consumers show little inclination to buy ahead, and both in this country and in the United States buyers are waiting until after the meeting of the International Tin Committee on March 22 before committing themselves further. A recent report issued by C. S. Trench & Company, Inc., of New York, states that consumers continue their policy of watchful waiting and, despite an improvement in tinplate operations, tinplate manufacturers have been no exception. Perhaps consumers are prepared to pay higher prices if necessary, but in the meantime are willing to gamble on the chance that the market will recede to nearer the low level set up by the buffer pool. The longer they wait, however, the larger the potential demand, and, it must be remembered, the smaller becomes the free stock, which by the end of March will probably amount to only about 16,000 to 17,000 short tons, whereas the buffer pool will hold about 15,000 tons. In effect, therefore, only a little over half the world's visible supply of tin will be available at world prices, while the balance will be priced on the basis of £230. A buying wave, therefore, when and if it materialises, will be met with smaller free supplies and a consequent rise in price.

Official quotations were as follow :—

Cash.—Thursday, £216 15s. to £217; Friday, £216 5s. to £216 10s.; Monday, £215 15s. to £216; Tuesday, £215 10s. to £215 12s. 6d.; Wednesday, £216 5s. to £216 10s.

Three Months.—Thursday, £215 15s. to £216; Friday, £215 10s. to £215 15s.; Monday, £215 to £215 10s.; Tuesday, £214 15s. to £215; Wednesday, £215 10s. to £215 15s.

Spelter.—This market remains on the dull side, and the slightly firmer tone has been almost entirely due to professional interest. An indication of the condition of many zinc concerns is given in a report recently issued by the Imperial Smelting Corporation. It announces that, owing to the unfavourable conditions in the zinc industry, the Corporation has not earned the full preference dividend. No decision has been made known in connection with the application for a higher import duty on zinc, which, if it materialises, will benefit substantially such concerns as Imperial Smelting.

Daily market prices :—

Ordinary.—Thursday, £13 17s. 6d.; Friday, £13 17s. 6d.; Monday, £13 17s. 6d.; Tuesday, £13 16s. 3d.; Wednesday, £13 16s. 3d.

Lead.—Although there is still room for much improvement, buying interest by consumers has been rather freer during the past few days, and the outlook for this metal is not quite so dull.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 15s.; Friday, £14 17s. 6d.; Monday, £14 16s. 3d.; Tuesday, £14 16s. 3d.; Wednesday, £14 18s. 9d.

Scrap.—The recently improved condition of this market has further strengthened, and there has been more desire on the part of consumers to place orders for deliveries ahead. Business from abroad continues to be quiet.

Approximate selling prices for old metal:—New aluminium cuttings, £70; rolled, £55 to £57; cast, £32; foil, £80. Copper, £38 to £43; brazierv, £36. Brass (clean), £20 to £24. Zinc, £10. Lead, £13 10s. Gunmetal, £38 to £39.

Company Meeting

Birfield Industries, Limited

The statutory meeting of Birfield Industries, Limited, was held at Witton, Birmingham, recently. MR. HERBERT E. HILL (vice-chairman), who presided in the absence of Mr. E. J. Hardy (chairman), describing the extent of the company's interests, said that they owned the whole of the share capital of Hardy, Spicer & Company, Limited, and of the Laycock Engineering Company, Limited. Hardy, Spicer & Company, Limited, in turn owned the whole of the share capital of the Phosphor Bronze Company, Limited, Forgings & Presswork (Birmingham), Limited, and Salisbury Axle Company, Limited. The main activity of Hardy, Spicer & Company, Limited, was the manufacture of universal joints and propeller shafts for the motor industry. Phosphor Bronze Company, Limited, manufactured all kinds of non-ferrous castings, together with a factoring department handling bar stock, sheets, etc. They had recently installed a modern centrifugal casting department which was already in production. The Forgings & Presswork Company, Limited, was chiefly interested in the manufacture of forgings and pressings, a large proportion of which it supplied to Hardy, Spicer & Company, Limited. The Laycock Engineering Company, Limited, made component parts for aeroplane engines, fittings for railway carriages and locomotives, propeller shafts for the heavy motor industry, garage equipment and general engineering supplies. Large extensions of the premises and plant of this company had recently been completed and further extensions would be made in the near future.